HOW AUSTRALIAN TECH CHANGED THE WORLD

PART 1 STARTS HERE

apc

JUNE 2022 #507 | YOUR EXPERT GUIDE TO TODAY'S TECH

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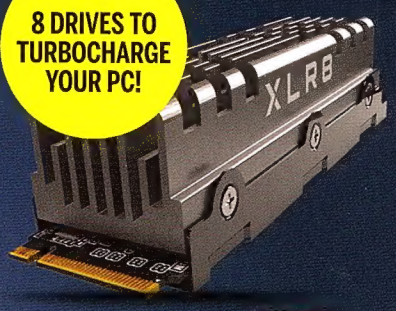


RATED:

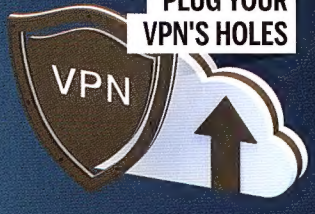
SPEEDY SSDs

GEN 4 GROUP TEST

SECURED:

NEXT LEVEL PRIVACY

PLUG YOUR VPN'S HOLES



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- HIDDEN WINDOWS TWEAKS

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FUTURE

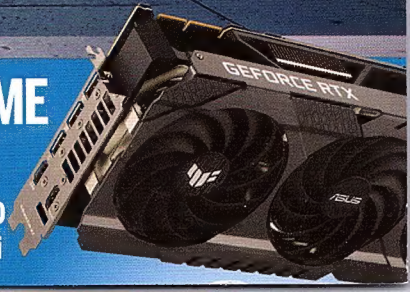
HOW-TO

UNLOCK WIN 11'S TOOLBOX

MASTERING TASK MANAGER

ULTIMATE GAME WEAPONS

AMD RYZEN 5800X3D + NVIDIA RTX 3090Ti



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- Multi-WAN series LTE routers (i.e. Vigor2866 LTE, Vigor2865 LTE, Vigor2927 LTE series) support Load Balancing and Failover functions.
- Single WAN series LTE routers support failover functions between xDSL/ Ethernet/LTE connections for Vigor2620 LTE series.

Vigor2865 LTE Series

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- SPI Firewall, 802.11ac Wave 2 Wi-Fi
- 16 x VLANs, 32 x VPN tunnels (including 16 x SSL-VPN tunnels)
- Support Central VPN, AP, Switch Management

Vigor2927 LTE Series

Cat.6 4G LTE and Ethernet Security Firewall Routers

- Cat.6 4G LTE Multi-WAN routers with 2 x SIM card slots, 300Mbps download, and 50Mbps upload speeds
- 1 x fixed GbE WAN port, 1 x configurable GbE WAN/LAN port, 1 x USB port for 3G/4G LTE modem, and 2 x Wi-Fi WANs (Lac model)
- SPI Firewall, 802.11ac Wave 2 Wi-Fi
- 16 x VLANs, 50 x VPN tunnels (including 16 x SSL-VPN tunnels)
- Support Central VPN, AP, Switch Management

Vigor2866 LTE Series

Cat.6 4G LTE and VDSL2 35b/G.fast/Ethernet Security Firewall Routers

- Cat.6 4G LTE Multi-WAN routers with 2 x SIM card slots, 300Mbps download, and 50Mbps upload speeds
- VDSL2 35b/G.fast/ADSL2+ WAN port, 1 x configurable GbE WAN/LAN port, 1 x USB port for 3G/4G LTE modem, and 2 x Wi-Fi WANs (Lac model)
- SPI Firewall, 802.11ac Wave 2 Wi-Fi
- 16 x VLANs, 32 x VPN tunnels (including 16 x SSL-VPN tunnels)
- Support Central VPN, AP, Switch Management

Vigor2620Ln

4G LTE and VDSL2 35b/Ethernet Security Firewall Router

- Cat.4 4G LTE router with dual SIM card slots (SIM slot 2 for failover)
- VDSL2/ADSL2+, 1x configurable GbE WAN/LAN port
- 1 x GbE LAN port
- SPI Firewall
- 802.11n Wi-Fi
- 2 x VPN tunnels including SSL-VPN
- Central AP Management

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EDITORIAL

WHAT'S INSIDE *APC*

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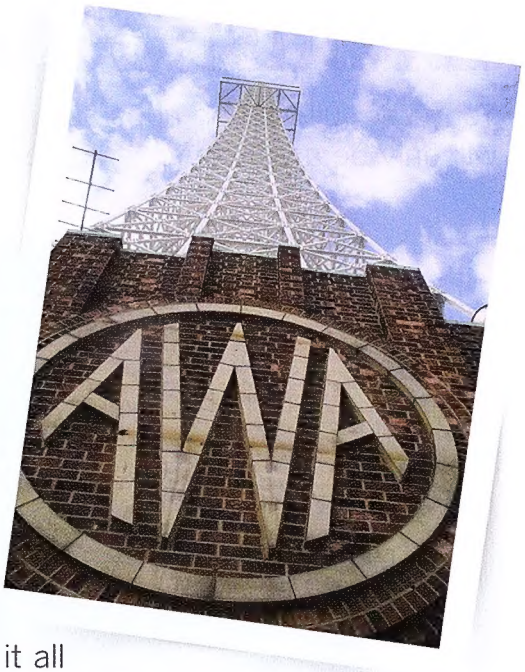
"This country and its clever people have contributed much to the technology that has made possible many of the products and services people around the world use today."



EDITORIAL

Australian tech story

How Aussies helped start it all

BEN MANSILL spends more time watching game streamers than actually playing games himself.

PIC: Remedial Building Services

We're not just avid consumers of tech, here in Australia. This country and its clever people have contributed much to the technology that has made possible many of the products and services people around the world use today. It's not really a secret that Australian scientists have been delivering genuinely impactful advances, but it's also not something that gets a lot of recognition – which is a shame because the stories are fascinating.

So we're doing that, here in *APC*. Starting this month Darren Yates embarks on a six-part journey through our proudest contributions to the modern world. Darren's main reference point for much of this is the electronic circuit, and in large part, how valves gave way to transistors, and with that vastly increased capability, scalability, portability, and power savings. These are all benefits we take for granted, and when designing something new today engineers rely on innovations many Australians brought to the world. Part 1 kicks off on page 98 this month, and we hope you enjoy the read.

I can't help but add a thought or two to our newest columnist Jon Honeyball's chosen topic this month. It's on page 18 and Jon shares his deep concern about how realistic war games are today, and when the setting is a modern war environment suddenly the escapism games offer is tempered darkly by the events in Europe.

My own gaming these days is mainly sim racing, but I sub to quite a few YouTube channels that cover war games, and it's now darkly surreal to watch these YouTubers play as soldiers, pilots, or tank commanders, excitedly celebrating each 'kill'. When the Russian invasion began some offered comment on how this affected what they do, explaining that it's still a game and a fantasy world – a point Jon dwells on.

As I take in my nearly-daily gaming content from the likes of Phlydaily, Oddbawz, Growling Sidewinder and Operator Drewski, among others, it's still a game I'm watching and nobody is being hurt. But to watch a tank battle in a setting that's European... it's just not possible to disconnect from the daily horror of this new reality.

These guys are all entertainers, and their chosen topic has had this most horrible dark cloud pass over it. I feel sorry for the conundrum they've been thrown in. They are doing a job, and providing entertainment. None take joy in or exploit the Russian invasion for clicks, and like all of us, want it to end soon, and peacefully.

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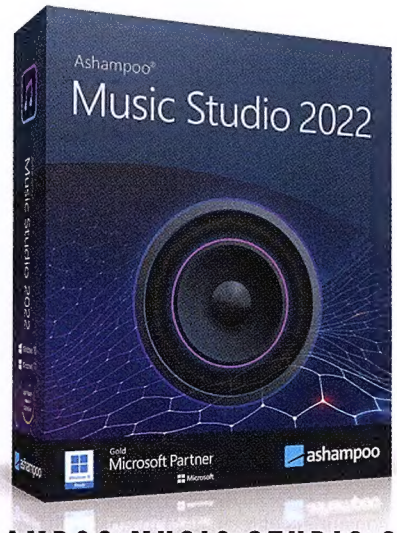

ASHAMPOO MUSIC STUDIO 2022

Music software to cut, organise and burn songs and audiobooks.

Ashampoo Music Studio 2022 is powerful versatile music software to edit, cut and burn audio files. Audio disc ripping happens quickly and missing track information is filled in automatically based on an online database. Files can be burned or converted into different audio formats.

The integrated audio editor enables users to modify or remove individual passages and allows them to split up tracks, e.g. MP3s, into individual parts, or recombine them with in-place snapping. Ashampoo Music Studio 2022 makes reorganising music libraries incredibly easy. Metadata can be modified, songs normalised, and tracks renamed based on customisable naming schemes, turning disorganised collections into well-formatted libraries.

Mix Tape helps users create song mixes with cross-fading or custom pauses. Furthermore, audio from existing video can be extracted and saved, e.g. to create ring tones or for use as background music in home-made videos.

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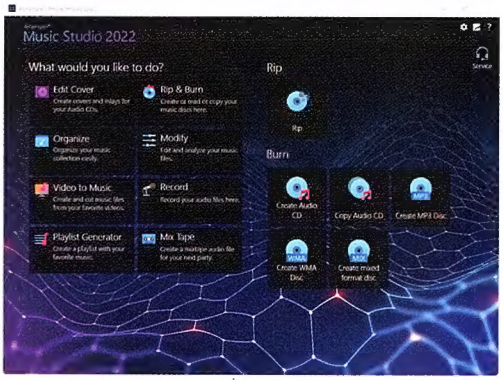

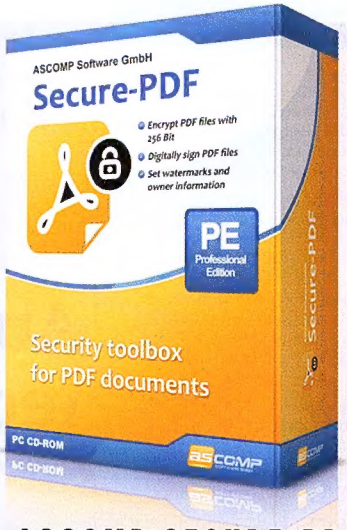

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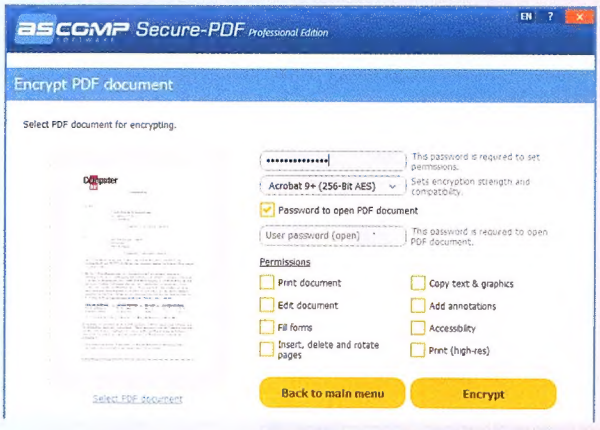

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CONTENTS

APC507 JUNE 2022

PEP UP YOUR PC!

30 WAYS TO BOOST YOUR COMPUTER

PAGE 62

- FREE & LOW COST UPGRADES
- INSTANT SPEED BOOSTS
- HIDDEN WINDOWS TWEAKS

THE RETURN OF GPU COMPUTING

Remember when we used to dream of harnessing the processing power of graphics cards? Darien Graham-Smith explains why those days are back **Page 58**

SECURE YOUR VPN

Jonni Bidwell casts doubt on the highly profitable VPN business, and explains how you can do better **Page 70**

ACER ENDURO URBAN N3

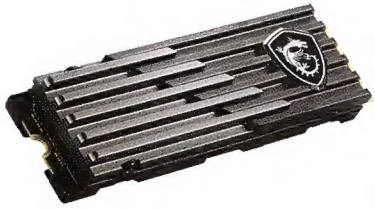
Acer brings rugged work laptops to the outdoorsy consumer **034**

PNY XLR8 DDR5 6000MHZ MAKO

041

AMD RYZEN 7 5800X3D

035



MSI SPATIUM M480 PLAY

039

SAMSUNG GALAXY TAB S8 ULTRA

040

ASUS TUF GAMING GEFORCE RTX 3090 TI OC

Meet the most powerful GPU on the market **036**

TECHNOTES

10 News
What's happening in tech

12 Tech brief
Nvidia uses GPU-powered AI to design GPUs

14 End user
The concept of a one-subscription-fits-all golden age is over

15 Random access
Bitcoin's biggest blackmarket bust

16 Two bits
Quantum computers are coming to steal your passwords

17 Tech talk
Nvidia unveils Hopper H100 datacentre GPU

18 One more thing
Is the ultra-realism of war-based games ethical?

22 Futures
The future of flavour could be digital

26 A-list
The best products on the market, as picked by our editors

29 The list
The top microphones

25 How it works
Steam Deck

30 Gadgets
Techy toys and trinkets

THE LAB

32 Asus Vivobook 16X OLED
33 MSI GE76 Raider
34 Acer Enduro Urban N3
35 AMD Ryzen 7 5800X3D
36 Asus TUF Gaming 3090Ti
37 Deep Cool AK400 CPU cooler
38 Silicon Power XS70
39 MSI Spatium M480 Play
40 Samsung Galaxy Tab S8 Ultra
41 Logitech G413 SE
41 PNY XLR8 DDR5 6000MHz Mako
42 Dell Ultrasharp U3223QE
43 DrayTek Vigor2865Lac

SOFTWARE

44 Windows
45 Apple Mac
46 Android apps
47 Linux

FEATURES

48 Gen 4 SSD group test
Rejoice, for ridiculously quick PCIe Gen 4 drives are now almost mainstream

58 The return of GPU computing
Remember when we used to dream of harnessing the processing power of graphics cards?

FEATURES CONT...

62 Pep up your PC: 30 ways to boost your computer
PC repair expert Lee Grant reveals dozens of ways to pep up your computer – and a few ways not to

70 Secure your VPN
Jonni Bidwell casts doubt on the highly profitable VPN business, and explains how you can do better

PC BUILDER

78 System news
Mark Williams has been waiting a long time for something to happen, and Nvidia obliged.

79 Market watch
A sampling of PC systems available

HOW TO

84 Quick tips
Solving a variety of tech problems

88 Windows
Advanced Windows 11 tips: Task Manager

90 Macintosh
Rename multiple files

92 Linux
Discover the super-charged file manager

MASTERCLASSES

94 Raspberry Pi
Create your own Chromecast device

98 Electronics
Tech that changed Australia (and the world) – Part 1

DOWNTIME

100 Machine of the month
Tandy TRS-80 Color Computer (1980)

102 Gaming reviews
High-performance playtime

106 Game changer
Binary Domain

110 Retro
What's next for the ZX Spectrum Next?

114 Chip chat
The less than serious news page

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Turn to page 20 now to find out how

"Championing technology doesn't mean we're unrelenting yes-men and -women, however, and APC aims to be as objective as possible in all our coverage."

HOW WE DO IT

Inside *APC*

Find out all about *APC*'s editorial policies, test practices, how to read the benchmark results, and more.

APC is Australia's oldest consumer technology magazine – having been consistently in print for forty years, since our first issue way back in May 1980 – and we take that heritage and responsibility very seriously. While our focus is obviously on the personal computer the very definition of the PC has changed and shifted markedly since the early 1980s. As such, we touch on many other areas of tech, too, from smartphones and apps to peripherals, accessories, and beyond. We have two goals: to find the best modern tech and to help you make the most of it.

We're also an open church in terms of platforms. We know most people aren't wed to a single brand's products and use a variety of devices. And, like you, *APC*'s journalists want to know what's good in tech – no matter what platform it resides on.

Independent reviews

Championing technology doesn't mean we're unrelenting yes-men and -women, however, and *APC* aims to be as objective as possible in all our coverage. That means identifying the best products from multiple perspectives – the best performance, best value and best features and, ideally, the products that offer the best mix of these three attributes.

As a matter of policy, reviews published in *APC* are not shared with product-makers prior to print. We will contact vendors under certain conditions; for example, if we have a problem testing a product that seems to indicate it may be faulty, or to invite a vendor to clarify how a particular feature works. If an *APC* reviewer has any potential conflicts of interest involving a brand, the review will always be assigned to another writer.

Labs testing

APC strives to conduct the most rigorous, objective scientific tests and benchmarks we can so as to make our reviews as unbiased as possible. We use a variety of tools and programs for this, including many freely available benchmark suites for assessing media encoding, general system performance including storage read and write speeds, gaming and battery life.

In most cases, for the benchmark results published in *APC*, you can assume that higher is better. There are certain tests that deviate from this rule where the opposite is true; in those cases, we've flagged the results with a note explaining as such.

We use both tables and graphs for displaying results; the latter offers better ease-of-readability, but tables are more compact, so we use these in most cases where thoroughness is preferred. ■

APC TESTBED

The current *APC* testbed used in the Labs for benchmarking all components. This testbed is updated as new and relevant technology comes on stream.

CPU	AMD Ryzen 7 5800X
Motherboard	Asus ROG Crosshair VIII Dark Hero
GPU	Zotac RTX 3080 Ti AMP Extreme Holo
Memory	Crucial Ballistix Sport DDR4-3600 2x16GB
Primary SSD	Adata S70 2TB NVMe
Secondary SSD	Samsung 980 Pro 500GB NVMe
Cooling	Nzxt X73 360mm AIO
Case	Thermaltake Core P8
Power Supply	Corsair AX1000

APC AWARDS

***APC* EDITOR'S CHOICE**
When a reviewed product scores 4.5 out of 5 or higher, it carries the Hot Award. These are products that exceed expectations and deliver a quality experience up there with the very best.

***APC* HIGHLY RECOMMENDED**
You will see this award if a reviewed product has scored four out of five stars. It means most people can expect satisfying performance from the product, and that we would use it ourselves.

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TECHNOTES

ALL THE NEED-TO-KNOW TECH NEWS

PIC: Microsoft

MICROSOFT 365 IMPROVEMENT COMING

Update allows switching between work and personal accounts.

An update coming to Microsoft 365 web apps will allow users to switch freely between work and personal accounts at last.

Managing workloads when juggling a plethora of different email accounts can be a pain for the best of us. But with the latest update, Microsoft 365 users will no longer need to rely on finicky workarounds to switch contexts effectively.

Users will now be able to sign into multiple Microsoft accounts in the same browser, and switch between these accounts without needing to sign out and back in or use private browser windows. According to Microsoft, this feature will benefit consultants who need to regularly access emails from different external companies, as well as consumer users switching between their corporate workloads and personal tasks

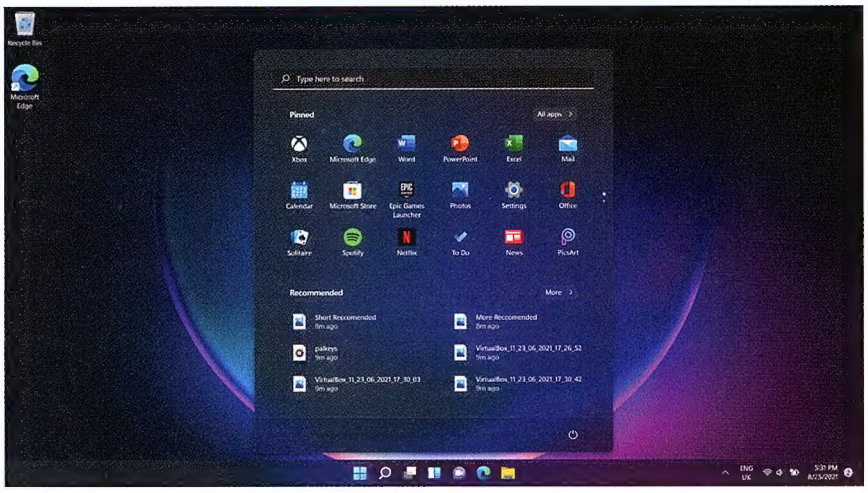
PIC: Epic Games

THE UNREAL ENGINE 5 ERA BEGINS

The new 3D and game engine enters full release.

Adoption of UE5 will mean different things for different studios, but the big themes are workflow streamlining and high-fidelity geometry and lighting. The 2020 Unreal Engine 5 reveal led with its new "micropolygon geometry system," Nanite, and its "global illumination solution," Lumen. With Nanite and Lumen, Epic says that developers can import film-quality 3D assets with "massive amounts of geometric detail" and set up dynamic lights without worrying about certain complex technical steps, especially those to do with optimisation. The engine handles the 'making it run on our PCs' part, or at least more of it.

There are some features specific to open world games, too. One of those features is World Partition, which handles the on-the-fly loading and unloading of open worlds as players move through them.



PIC: Microsoft

OS NEWS

Windows 11 still struggles to convince users to upgrade

But it only has itself to blame.

Despite all the hype behind Microsoft's latest operating system, it seems to be struggling to get users to upgrade several months after its release. According to a survey by market analyst AdDuplex for April 2022, Windows 11 has had a growth of less than 0.4 percent month-over-month. This puts it at a 19.7 percent total user base, compared to 19.4 percent from last month. Meanwhile, Windows 10 21H2 has a total install base of 35 percent while Windows 10 21H1 is installed on an additional 26.4 percent of Windows computers.

Another study from Lansweeper, an IT asset management company, found that there were more PCs in its study running Windows XP (1.71 percent) than Windows 11 (1.44 percent).

However, it's important to note that only 60,000 Windows 10 and 11 PCs were part of the AdDuplex survey, and that was only for PCs running the AdDuplex software in the first place. The Lansweeper study also used a very small sample size, so take all this data with a pinch of salt.

The most pressing issue by far is the strict installation requirements – including a Trusted Platform Module (TPM) 2.0 cryptoprocessor. This would require many businesses and casual consumers to upgrade their PCs to at least an Intel eighth-gen processor or an AMD Zen+ or Zen 2 CPU. This isn't something that a lot of off-the-shelf users are even going to consider doing. It's also an expensive and difficult proposition considering the ongoing components shortages.

This even appears to be an issue with Microsoft itself, as a Program Manager was caught running an unsupported PC during the Windows Insider Webcast.

Windows 11 also has interface issues such as the location of the Taskbar, the Start menu being an odd mix of Windows 10 and a touch interface, the Search app being launched alongside the Start menu when searching, and more.

Another issue is the increasing amount of data sharing with Microsoft, with no way to toggle it off unlike Windows 10. And the tech giant has been getting pushier about using its services like being prompted to create a Microsoft account, using OneDrive cloud storage, and being bombarded with messages to give Microsoft Edge a try if you install other browsers instead.

Windows 11 also has interface issues such as the location of the Taskbar, the Start menu being an odd mix of Windows 10 and a touch interface, the Search app being launched alongside the Start menu when searching, and more.

Intel opens next-gen chip fab

$4.2B fab expansion is now open for business.

Intel has announced the grand opening of its new semiconductor fab expansion at its D1X facility in Oregon. Costing $4.2 billion, the new Mod3 expansion delivers an "additional 270,000 square feet of clean room space to develop next-generation silicon process technologies". That'll come in handy for Intel's aggressive process node ramping plans.

Intel plans to rapidly introduce new process nodes over the coming years, from Intel 7 today to Intel 18A by the middle of the decade, and it's planning to invest heavily in its Intel-owned and operated manufacturing facilities to deliver on each of those.

"Since its founding, Intel has been devoted to relentlessly advancing Moore's Law," Pat Gelsinger, Intel CEO, says. "This new factory space will bolster our ability to deliver the accelerated process roadmap required to support our bold IDM 2.0 strategy. Oregon is the longtime heart of our global semiconductor R&D, and I can think of no better way to honour Gordon Moore's legacy than by bestowing his name on this campus, which, like him, has had such a tremendous role in advancing our industry."

PIC: Bored Ape Yacht Club

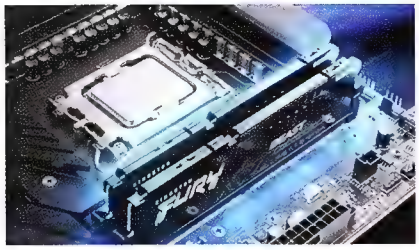
NFT BORED APE MARKETPLACE GETS HACKED

People lose 'millions' in ape pictures.

Bored Ape Yacht Club – the best-known collection of NFT "art" – was hacked in April. Owning a Bored Ape up to this point has required forking out a ludicrous amount of cash for what we have to say are some of the least charming pieces of art ever seen.

The Bored Ape Yacht Club's Instagram page and Discord were hacked, and the culprits sent out messages on both about a new mint of NFTs and what's called a "land sale" (it does not involve land) to pilfer ape holders' wallets.

Many customers were suckered by official-seeming messages, and clicked on a link connecting their wallet, which then transferred its ape-y contents to the hackers. The hackers in question have got away with assets that have a theoretical value in the low millions.



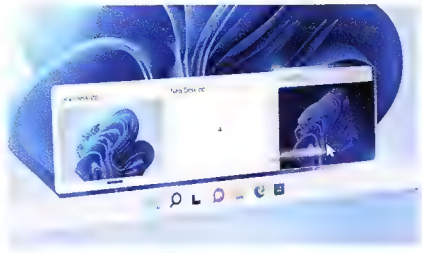
PIC: MSI

DDR5 OVERCLOCKED TO 10,004 MT/S

New world record shows DDR5's potential.

MSI Gaming Overclocking Team member Kovan Yang has managed to coax a stick of DDR5 to achieve DDR5-10004. Yang pushed a single 16GB stick of Kingston Fury Beast DDR5 RAM to 5,001.8MHz (10,004 MT/s, DDR5-10004). The MSI OC Team DDR5 overclocking achievement is significant, as it is the first to poke its nose over the 5,000MHz / DDR5-10000 threshold.

The overclocking details suggest the CPU was liquid nitrogen cooled, but there is no specific cooling method specified for the RAM. As other top 10 entrants sometimes note that LN2 is used to cool the RAM, it is quite certain this is the case with Kovan Yang's submission too, given the extreme speeds involved.



PIC: Microsoft

MICROSOFT SAYS THE FUTURE OF WINDOWS IS THE CLOUD

Plans to integrate Windows 11 and Windows 365 via hybrid experience.

The company plans to bring Windows 11 and Windows 365 closer together, with deep integrations with its Cloud PC service that Microsoft says will enhance hybrid work scenarios and productivity workflows for companies using or deploying Windows PCs to their employees.

In the near future, Microsoft is planning to introduce several new cloud-based features that are designed to integrate the local Windows 11 desktop experience with the company's cloud-powered Windows 365 enterprise service. In the future, users with access to a Windows 365 Cloud PC will be able to access and interact with that cloud instance directly from the Windows 11 desktop interface, with integration with common areas of the system such as the Taskbar and Task View. ■

TECH BRIEF

Nvidia uses GPU-powered AI to design GPUs

Was AI instrumental to the advancements behind Ada Lovelace?

Nvidia's chief scientist recently talked about how his R&D teams are using GPUs to accelerate and improve the design of new GPUs. Four complex and traditionally slow processes have already been tuned by leveraging machine learning (ML) and artificial intelligence (AI) techniques. In one example, using AI/ML accelerated inference can speed a common iterative GPU design task from three hours to three seconds.

Bill Dally is chief scientist and SVP of research at Nvidia. HPC Wire has put together a condensed version of a talk Dally shared at the recent GTC conference, in which he discusses the development and use of AI tools to improve and speed up GPU design.

In his talk, Dally outlined four significant areas of GPU design where AI/ML can be leveraged to great effect: mapping voltage drop, predicting parasitics, place and routing challenges, and automating standard cell migration.

Mapping voltage drop shows designers where power is being used in new GPU designs. Using a conventional CAD tool will help you calculate these figures in about three hours, says Dally. However, once trained, Nvidia's AI tool can cut this process down to three seconds. Such a reduction in processing time helps a lot with a process like this, which is iterative in nature. The process, as it stands, offers 94 percent accuracy, which is the tradeoff for the huge iterative speed increase.

Predicting parasitics using AI is particularly pleasing for Dally. He says that he spent quite some time as a circuit designer and this new AI model cuts down a lengthy multi-personnel, multi-skilled process.

Again the simulation error is reasonably low, at <10 percent in this case. Cutting down these traditionally lengthy iterative processes can free up a circuit designer to be more creative or adventurous.

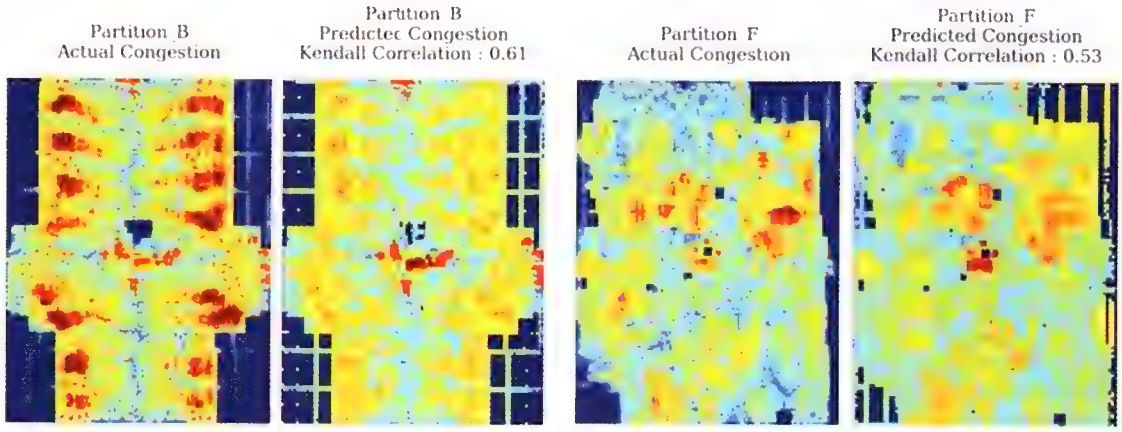
Place and routing challenges are important to chip design as they are like planning roads through a busy conurbation. Getting this wrong will result in traffic (data) jams, requiring rerouting or replanning of layouts for efficiency. Using Graph Neural Networks (GNNs) to analyse this issue in chip design helps highlight areas of concern and act on issues intelligently.

Lastly, automating standard cell migration using AI is another very useful tool in Nvidia's chip design toolbox. Dally talks about the great effort previously required to migrate a chip design from seven to five nanometer, for example. Using reinforcement learning AIs, "92 percent of the cell library was able to be done by this tool with no design rule or electrical rule errors," he says. This is welcome for its huge labor savings "and in many cases, we wind up with a better design as well," continues Dally.

Last year at GTC, Dally's talk stressed the importance of prioritising AI and told of the five separate Nvidia labs indulging in AI research projects. We can't wait to see and hear about whether Nvidia's homegrown AI tools have been important to the design of Ada Lovelace GPUs and getting them ready for TSMC 5nm. Dally seems to hint that automating standard cell migration using AI was used in some 7nm to 5nm transition(s) recently.

Mark Tyson ■

Using AI/ML accelerated inference can speed a common iterative GPU design task from three hours to three seconds.



AI can now predict the effect adding new circuitry will have on data and electrical congestion.

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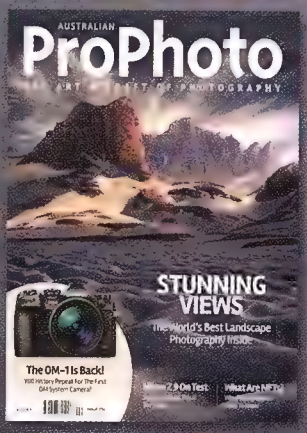

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END USER

Enjoy this golden age, because game subscription services are going to fragment

With Sony joining Microsoft in the subscription market, the concept of a one-subscription-fits-all golden age is over, writes Shaun Prescott.

When Microsoft launched its Xbox Game Pass service into beta in 2017, it seemed too good to be true. For ten bucks a month you could access a library of more than 100 games ranging from blockbusters through to small indies. It was the long-dreamed-of "Netflix for games", basically, and in 2022 it is still absolutely dominant, largely because it has no competition.

That changed in April, with Sony's inevitable announcement of a PlayStation equivalent. Inheriting the PS Plus label, Sony's offering has three tiers, but the middle tier – which competes directly with Xbox Game Pass – is already promising more games than Xbox's, for a couple of dollars more a month. At the time of writing, the PS Plus library hasn't been announced, and besides, there are a few other caveats: unlike Microsoft, Sony won't release its big tentpole releases straight onto the service (don't expect, say, *God of War: Ragnarok* on PS Plus at launch), and Sony has no PC equivalent.

Whether PS Plus or Xbox Game Pass ends up winning, or whether they both live in harmonious, profitable bliss, is a little hard to guess. What matters more, is the seeming inevitability that subscription-based game libraries are probably going to go the way of subscription-based TV. In short: they're fragmenting. Sure, it's a little different, because the Sony and Microsoft ecosystems don't overlap, but the big third-party publishers can walk the platform tightrope (not to mention PC).

You can probably recall the halcyon days of streaming in Australia, back in 2015, when Netflix and Stan were basically the only options. Not having a tonne of choice is actually good for the consumer in this case, because these big platforms (one global, the other regional) were where the stuff you wanted to watch ended up. Now, with the proliferation of studio-specific streaming services like Disney+ and Paramount+, not to mention also-rans like Binge, the chance of everything you want to watch being on one outlet is close to zero.

It's not that these things are costly; the monthly fees are usually between $10-$15 and there are no lock-in contracts. You can happily graze, in other words. But will the same principles apply in games if, for example, all the major publishers decide to strike out on their own to offer independent subscription services? What if indie publishers abscond from Game Pass to create their own Indie Prime service? What if Microsoft, and Sony, in a decade or less, end up stripped of their third-party offerings due to the fragmentation of subs services?

SHAUN PRESCOTT
Author, *PC Gamer* editor and passionate technology observer, Shaun covers trending tech topics for *APC*.

It's worth pointing out that Electronic Arts actually did this. EA Play exists on PC, PlayStation and Xbox, and is now bolted onto Xbox Game Pass. EA's modern library isn't exactly voluminous nowadays, aside from its usual outlay of annualised sports titles. If Ubisoft struck out on its own, that would arguably be a different story, likewise Square Enix, or Bandai Namco. But that's only if they aren't acquired: Microsoft has acquired (or announced its intention to acquire) Bethesda and Activision over the last two years, which means titles ranging from *Fallout*, *The Elder Scrolls* and *Call of Duty* could likely be Xbox Game Pass exclusives. Microsoft is in a good position.

Further fragmentation is close to a dead certainty. Publishers aren't going to sit around and let platform holders capitalise on their content if they can make more on their own, and the publishers with large and diverse catalogues are likely to win big. In the end, subscription services are likely to become more confusing and, with inevitable price bumps, more expensive. It's still arguably better than ten years ago when major publishers dominated, the AAA had declined, and indies were yet to blossom. Now we've got more of everything, but that everything is going to be spread pretty thin in the coming years. ■

Bitcoin's biggest blackmarket bust

How the seemingly anonymous nature of Bitcoin led the IRS to take down the largest global pedophilia network in history.

Ask anyone 10 years ago about Bitcoin and they'd describe it as 'anonymous digital cash' – but according to a new book by *Wired* writer Andy Greenberg, there's an assumption in that description that couldn't have been more wrong.

While the mysterious cryptocurrency creator Satoshi Nakamoto suggested in 2008 that one of the five fundamental principles of Bitcoin was that "Participants can be anonymous", one of the other essential components of the cryptocurrency was that the process of generating new coins was baked into the creation and validation of a public ledger called the blockchain. This detail means that every exchange of the cryptocurrency all the way back to the very first transaction has been permanently etched into the very number sequences that make up the currency, and while initially it was possible to create wallets that couldn't be traced back to the people that owned them, over time it becomes virtually impossible to avoid identifying links.

It took about five years for the first security researchers to reverse engineer some robust techniques to trace and identify Bitcoin transactions, and in 2014 a tech startup called Chainalysis, founded by South African entrepreneur Jonathan Levin, began advancing the field quickly. This company started following transactions until Bitcoins were moved to a wallet that could be identified, or one that used an exchange where users' information could be demanded through traditional legal avenues. Chainalisis then began clustering accounts that looked as though they belonged to a single individual using transaction patterns like single payments from multiple accounts, and following 'peel chains' that sent change from transactions to different wallets.

The software was used in subsequent years to trace everything from the proceeds of the half a billion dollar Mt. Gox raid, to the identification of the founder of AlphaBay (a dark web marketplace that grew to 10 times the size of Silk Road). But in 2017, the Chainalysis tracing software was used under the direction of the UK's National Crime Agency to map the accounts associated with a Bitcoin address identified as part of the financial network of a child sexual abuse material repository on the dark-web called *Welcome to Video*. Unlike most of the criminal cryptocurrency trails Levin followed, the network of *Welcome to Video* crypto accounts and the vast majority of those transacting with them showed no attempts to conceal the identities of their owners.

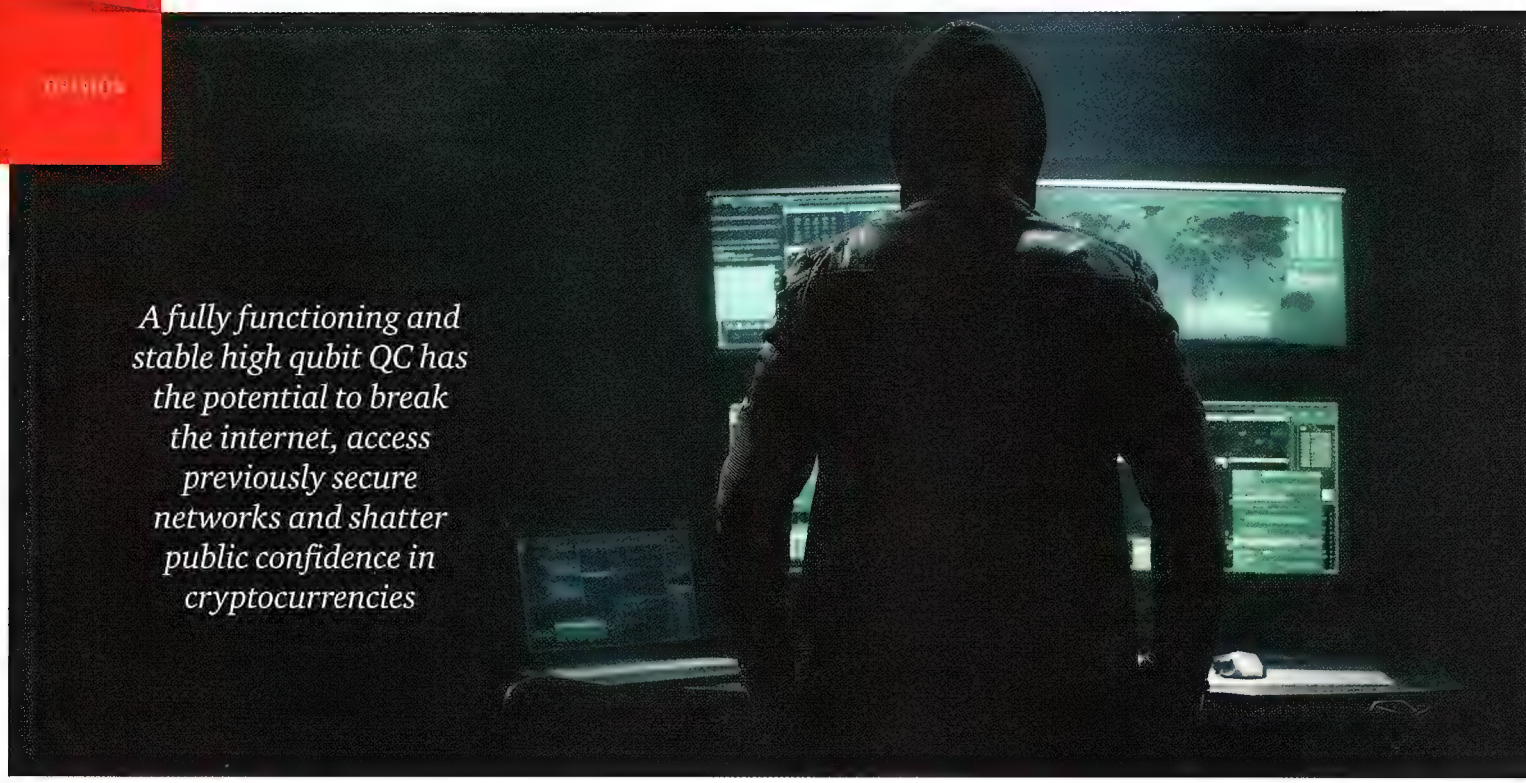
In addition to showing the most obvious incriminating evidence Levin had encountered in his career, the *Welcome to Video* site was extensive; it ultimately proved to be the largest collection of child sexual abuse material of any prosecuted case in history, with over 250,000 videos. Levan decided to share his findings with two agents from the US Internal Revenue Service that he had worked with to track down the AlphaBay founder.

In the years following the IRS developed enough evidence to arrest 337 paedophiles around the world– including the site's Korean owner and operator Son Jon-woo – and a wide range of abusers from the assistant principal of a high school in Georgia, to a Texan Homeland Security agent, a Hungarian ambassador to Peru, and even a former congressional staffer.

The IRS commissioner Charles Rettig described this case as "this generation's Al Capone" with all the significant moments of this enormous operation detailed in Greenberg's new book *Tracers in the Dark*. ■

JOEL BURGESS
When not reviewing PCs for *APC* and writing our funny pages, Joel likes to ponder tech and how it's used.

Every exchange of the cryptocurrency all the way back to the very first transaction has been permanently etched into the very number sequences that make up the currency.



A fully functioning and stable high qubit QC has the potential to break the internet, access previously secure networks and shatter public confidence in cryptocurrencies

TWO BITS

Quantum computers are coming to steal your passwords and cryptocurrencies

QCs are exceptionally adept at breaking cryptographic keys.

Quantum computing is coming. While still a very nascent technology, the physics side of things is advancing rapidly, and work on the engineering side continues apace. Quantum computers have the potential to change the world. Their power is set to dramatically advance fields as diverse as climate science, biology and machine learning, but there's another application, and it's the one we know the least about. The governments of the world see quantum computers as a tool of espionage, and the reason is? Passwords and encryption. A fully functioning and stable high qubit QC has the potential to break the internet, access previously secure networks and shatter public confidence in cryptocurrencies. Forget Y2K, think Y2Q.

Firstly, a refresher. Computers as we know them are based around the use of binary digits: 1s or 0s. A quantum bit, or a qubit, can exist as a 1, a 0, or – most importantly – *both at the same time*. A high qubit QC has the potential to perform calculations that no classical computer can ever hope to match, and this includes the cracking of much of the encryption that underpins the security of the internet, including the financial and government sectors as well as cryptocurrencies.

CHRIS SZEWCZYK
A life-long PC tech enthusiast, Chris has worked acoss the industry in many areas as a product and technology expert.

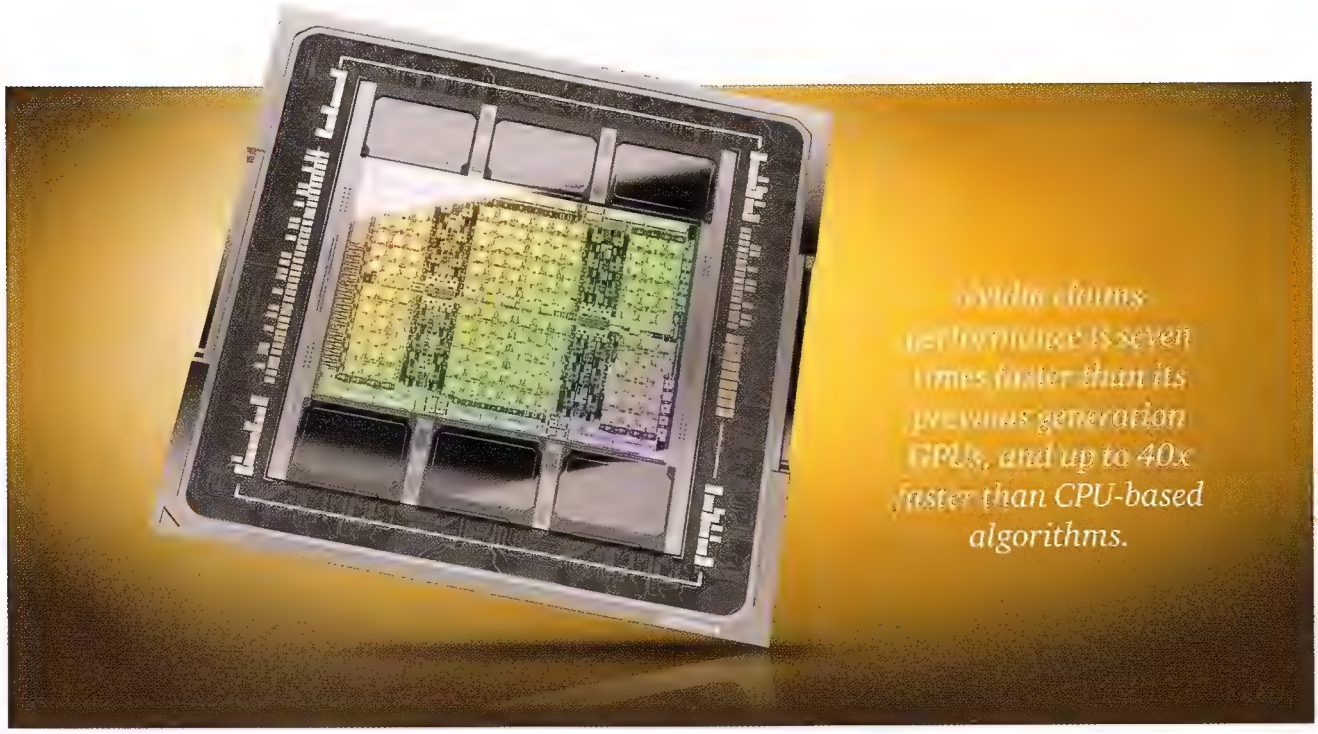
Work is underway to migrate current cryptographic algorithms to those that are resistant to quantum attacks. It's likely that the most critical systems have already migrated, including key military and government systems and the financial systems of advanced countries. But, you can be sure there are a lot of vulnerable networks out there. As the governments of the world pour billions of dollars into the QC space, it's crystal clear that the time to move to quantum resistant cryptography is NOW, before it's too late.

Quantum computers present an existential threat to many cryptocurrencies. Bitcoin is the logical example to use. Bitcoin's core protocol relies on Elliptic Curve Digital Signature Algorithm (ECDSA) to create a private key and a corresponding public key. A sufficiently powerful QC can derive the private key from the public key using Shor's Algorithm. This allows an attacker to access the wallet. ECDSA is not easy to crack, but it's possible with enough qubits. Ignoring this vulnerability is fraught with danger.

Bitcoin's Satoshi Nakamoto-era wallets are particularly vulnerable due to their use of pay to public key (p2pk) addresses. QC sceptics will say that BTC developers can hard fork to a quantum resistant signature scheme, and that's certainly true, but those dormant wallets will remain vulnerable. What if a million bitcoins suddenly appeared on the market? Confidence would plummet and the price of bitcoin would crash.

A hundred billion dollars, give or take, is a juicy target for a rogue state. A country like China might wish to destroy all confidence in crypto in order to remain in control of its financial sector. Decentralised money is an anathema to an authoritarian government. The US might covertly attack crypto in order to prevent its use by criminals. North Korea might just need the money. There are many reasons for those in power to bring down crypto.

Some cryptos have already adopted QC secure signature schemes. Others, including Ethereum and Cardano, have quantum signatures or protection on their roadmaps. Crypto users are tribal by nature but it's time to get past the FUD and take quantum computers seriously. Developers need to act now. It might be a year or 10, but if a black swan event occurs, it'll be far too late to do anything about it. ■


Nvidia claims performance is seven times faster than its previous generation GPUs, and up to 40x faster than CPU-based algorithms.

Powering ahead

Nvidia has unveiled its Hopper H100 data centre GPU. Will its dramatic performance lead the way for consumer silicon?

We've known Nvidia has been working on next-generation GPUs for some time, but it officially unveiled its Hopper architecture and the H100 datacenter GPU at GTC 2022. Hopper H100 will replace the Ampere A100, which replaced the Volta V100. Designed for supercomputers, with a focus on AI capabilities, H100 provides numerous updates to the current A100.

Built with 80 billion transistors on a custom TSMC 4N process, Hopper ups the ante in many ways. It supports a PCIe 5.0 interface, the first GPU to do so, as well as 4th generation NVLink, which can deliver up to 900GB/s of bandwidth, while PCIe 5.0 tops out at 128GB/s, 1.5x and double the bandwidth of the A100, respectively. H100 will have 80GB of HBM3 memory with 3TB/s of bandwidth, x1.5 faster than the A100's HBM2E. The H100 can also deliver up to 2,000 TFLOPS of FP16 and 1,000 TFLOPS of TF32 compute – triple the performance of the A100. FP64 Hopper also adds improved FP8 support with up to 4,000 TFLOPS of compute, six times faster than the A100. For general purpose FP64 instructions, Hopper can do up to 60 TFLOPS – that's three times faster.

New to Hopper are DPX instructions, designed to accelerate dynamic programming and help with a range of algorithms, including route optimisation and genomics. Nvidia claims performance is seven times faster than its previous generation GPUs, and up to 40x faster than CPU-based algorithms.

But this performance comes with a cost. Nvidia hasn't given details of price, but the TDP for the SXM variant that uses NVLink instead of PCIe sits at 700W, compared with 400W for the A100 SXM modules. That's a net improvement in efficiency, but also evidence of the slowing down of Moore's Law. A lot of that power goes to the interlinks with other GPUs, which are vital for increasing the scaling potential for supercomputers and their building blocks.

As with A100, Hopper will be available as a new DGX H100 rack-mounted server. Each DGX H100 system contains eight H100 GPUs, delivering up to 32 PFLOPS of AI compute and 0.5 PFLOPS of FP64, with 640GB of HBM3 memory. Nvidia then scales out to a DGX SuperPod with 32 DGX H100 systems, linked by an updated NVLink Switch system and Quantum-2 InfiniBand networking. A single H100 SuperPod has 256 H100 GPUs, 20TB of HBM3 memory, and up to one ExaFLOPS of AI compute potential.

JARRED WALTON
Jarred Walton has been a PC and gaming enthusiast for over 30 years.

It's not just Hopper, Nvidia also has its Grace CPU that will provide up to 72 CPU cores, paired with LPDDR5X ECC memory. Nvidia will offer Grace Hopper "Superchips" that combine a Grace CPU with a Hopper GPU on a single module, with a 900GB/s coherent interface between the two. There's also a Grace CPU "Superchip" with two CPUs on a module, 144 CPU cores, and 1TB/s of memory bandwidth. While Hopper will arrive later this year, Grace isn't due until Q3 2023.

While Nvidia likely won't use HBM3 or TSMC 4N for its upcoming Ada GPUs, and may not triple the performance of Ampere, there's speculation that the top consumer GPUs could double the performance of the RTX 3090. Based on Hopper, such rumours may not be that far-fetched. ■

© Nvidia

ONE MORE THING

No escape from reality

The ultra-realism of war-based games prompts Jon Honeyball to ask some ethical questions.

The horrifying news from Ukraine fills our daily news cycles with stories that are hard to comprehend. War is a terrible thing, and that such a thing could happen in a modern European country is impossible for me to understand. It's not that I haven't tried, it is that the unfolding situation is so far away from my life experience that it makes me stop and freeze up.

Today, communication is better than it has ever been. Smartphones allow everyone to be a citizen journalist. The use of drones for video capture is a new democratisation of technology too. I have even seen Twitter feeds analysing photographs of Russian pilots, working out who was where and at what time, based on deep facial recognition algorithms. If it's deemed appropriate for there to be war trials, then the sheer quantity of video data might be almost overwhelming in both quantity and quality.

Given the enormity of the unfolding horror, it might seem almost churlish to report on something that made me quite upset. I saw the reporting of an ITV news team caught in their car, under sniper attack. They managed to get out of the car and to safety, although several were wounded in the process.

This in itself was profoundly upsetting. But what really jarred was how realistic it looked. You might think that this is a somewhat stupid thing to say – it was the very definition of "real". But I suddenly felt quite queasy at the thought of all of those "shoot-em-up" games on consoles like the Playstation 5 and Xbox. The rendering quality has improved out of all proportion in recent years. I used to enjoy the early days of games like *Doom* and *Quake*; they not only had a context that was clearly off-planet, but the image quality was so obviously "not real" that it was possible to clearly differentiate the game from reality. Compartmentalising things is something we do, it's human nature.

Today, I'm not so sure. I wasn't, and still am not, able to rationalise my upset between the realisation that we have created a generation of game players who revel in their skillset in such games versus the abject horror of seeing it for real from a news team. I am sure that many players will say that there is no link, they are entirely two separate things, and that the comparison is both fatuous and offensive. But there is no excuse of "it's clearly not real" when presented with the astonishing capabilities of a modern game on a console. This will become even more true in the coming years.

I wonder how many people will watch the news, and then pick up the controller for their Xbox and fire up some battlefield game, often played with friends, where taking over a city is the ultimate goal. And I wonder how many of them will be struck at the extraordinary discomfort that this should be generating in their heads and their hearts.

I am no fan of censorship, outside of the obviously unacceptable images, but I worry how a significant portion of the gaming industry works, and where they will go with increasing image quality and virtual reality. I have no answers for this. But the similarities between the profoundly upsetting reality and the presumed pleasure of gaming has taken me to a dark place. ■

JON HONEYBALL
Jon Honeyball accepts that the grey hairs that have appeared are God's way of telling him he is old.

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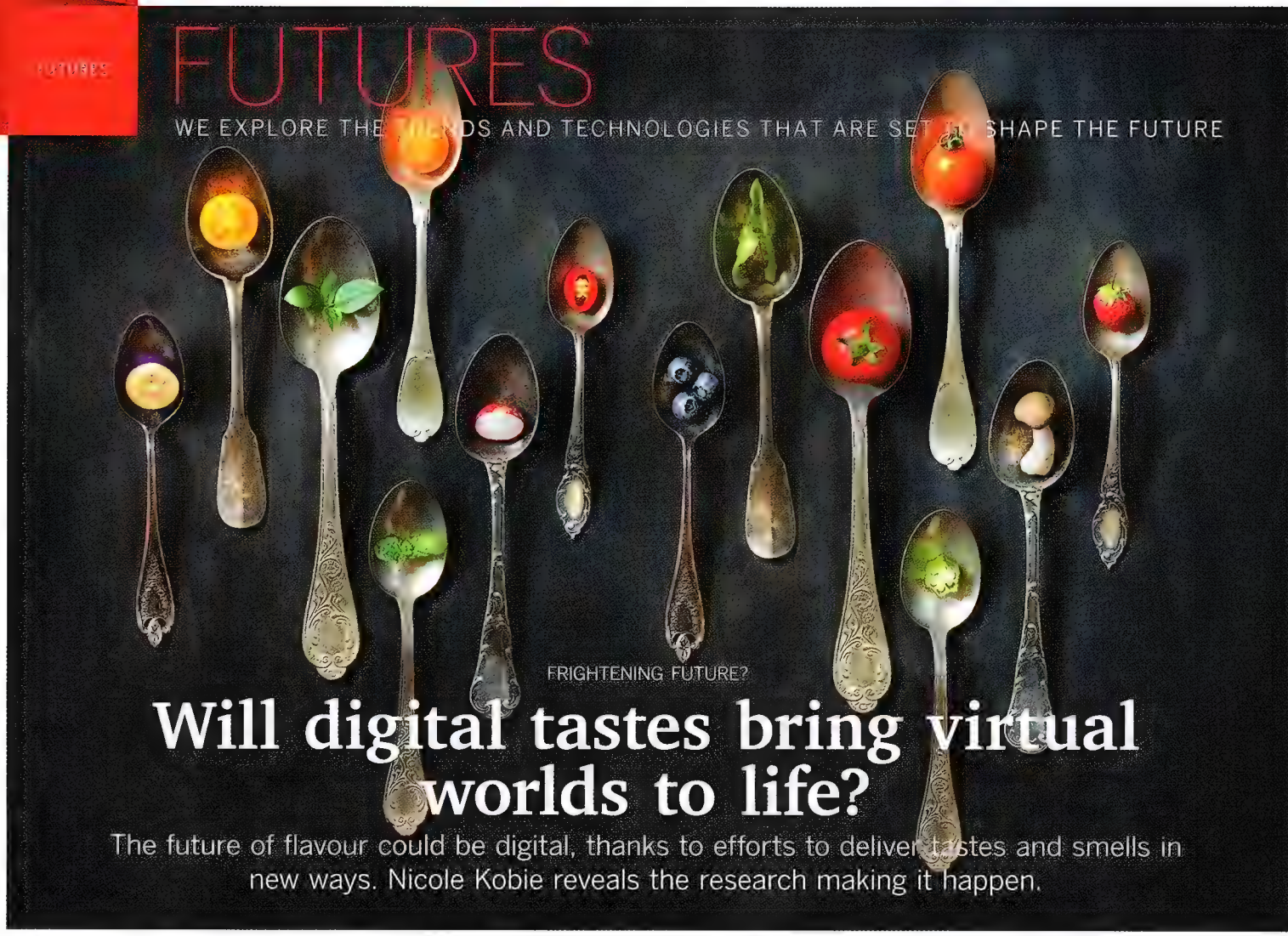


FRIGHTENING FUTURE?

Will digital tastes bring virtual worlds to life?

The future of flavour could be digital, thanks to efforts to deliver tastes and smells in new ways. Nicole Kobie reveals the research making it happen.

You're minding your own business, surfing the web idly, when an advert pops up for your local fast-food establishment. The pictured burger certainly looks delectable, but it's the smell wafting from your laptop that entices you to lick your display for a taste – and when you do, it's delicious greasy goodness (without the calories). The future of lunch may just be digital.

Researchers in Japan are the latest to demonstrate this idea. Homei Miyashita, a professor at Meiji University, Tokyo, demonstrated a prototype of what he calls "Taste the TV", developed in a lab where students spend their time creating digital taste devices. The TV uses combinations of ten canisters to create flavours that are sprayed onto a removable film on the display, where they can be licked by watchers, according to a Reuters report, with one student successfully asking the system to recreate the taste of chocolate during the demonstration.

"The goal is to make it possible for people to have the experience of something like eating at a restaurant on the other side of the world, even while staying at home," Miyashita said. Normally, we chew our food rather than lick it from plastic screens, but there are potential uses beyond selling snacks, added Miyashita, saying it could be used for online learning to teach cooks and sommeliers, or for virtual quizzes.

While licking a TV to taste what's on the screen is certainly novel, the idea of adding taste and smell to digital technologies isn't new; after all, "AromaRama" was used to augment the 1959 film *Behind the Great Wall*, with the competing "Smell-O-Vision" arriving the next year for *Scent of Mystery*.

So, why don't cinemas smell of anything other than popcorn now? The scent from the smell systems took too long to reach some of the audience, meaning that the impact was mistimed. It didn't help that it was accompanied by a loud hissing noise, causing distractions.

Digital taste sensation

More recent efforts have seen senses digitised. Miyashita's lab has also produced the "Taste Display", which sends electrical currents through a tasteless gel to produce different flavours, and an electric fork to make food taste saltier without the sodium. Meanwhile Singapore's Mixed Reality Lab has built a smartphone add-on called Scentee that releases smells developed by a Michelin-starred chef, in the hope of capturing the aromas of their

Smell-O-Vision failed to take off, but new research could make tech tasty.

restaurant. It could also be used to trigger coffee smells alongside your morning alarm or simply send a whiff of something to your friends (I'm not sure about this last one, for obvious reasons).

At his lab at the University of Maine, Nimesha Ranasinghe has created "virtual lollipops", electrode-filled chopsticks and current-carrying cups that use electrical signals to create tastes that aren't really there, with everything from mashed potatoes to lemonade. "What we have done is use electrical stimulation, a controlled weak electrical stimuli applied to the tip of the tongue," he told *APC*. "The digital lollipop... you put it inside your mouth and you can roll it on the tongue to see how the taste sensations differ in different areas of the tongue."

Various taste sensations can be achieved by changing the frequency of the current, the location where it's applied on the tongue, or even the conductive material . He uses silver, gold and platinum. "By the end of my PhD, I came up with a graph that showed the set of parameters – this frequency, this amplitude of current, this metal – applied on the tip of the tongue could stimulate sourness [with] up to 90 percent accuracy," he said. "Then we developed that for salty, bitter as well as sweet." Sour and salty are the easiest to replicate, while sweet and bitter are more complicated.

His work has since expanded beyond electrical stimulation to using thermal stimulation to recreate taste. "If you rapidly heat and cool the tip of your tongue, you can feel minor sweetness or bitterness," he said, though we'll add the warning to not try this at home. Cooling the tongue evokes mint or menthol, he adds, while heating it up – perhaps unsurprisingly – sparks a spicy sensation.

Ranasinghe is now working on ways to build his digital taste technology into utensils, and intensifying it by adding colours and smells. He describes a virtual cocktail where a mobile phone controls a specially designed martini glass to release smells and manage LEDs, with silver electrodes on the rim. "When you take a sip, your tongue will be stimulated and you will feel the sourness or saltiness, and then based on the smells released on the surface of the beverage you get the aroma combined with the different colour stimulation [from the lights]," he said. "By changing all of these parameters, we could augment the flavour perceptions."

The University of Maine's digital lollipop creates tastes using electrodes.

Floating tastes

Of course, digital taste need not only be delivered electrically; after all, "Taste the TV" uses spray cans of flavours to deliver its lickable sensations. Marianna Obrist is a professor of multisensory interfaces at UCL's department of computer science, and the cofounder of OWidgets, a smell-based application design startup. Her work uses a system called acoustic levitation to deliver tiny bits of food or drink without needing to lick anything by suspending molecules in the air and controlling them with sound waves.

"Levitation is the process of holding and moving an object in mid-air, without any mechanical support," she explained. "The applications of contactless manipulation of objects in mid-air is very attractive for gustatory interfaces, as it allows the levitation of taste stimuli or food morsels, so that the person only needs to use their tongue to pick them up in mid-air – like astronauts eat in microgravity. No attachments to the tongue or tubes are needed to the mouth, in order to stimulate our sense of taste."

LeviSense, as she and her fellow researchers call it, could be used in virtual reality or digital worlds, to create "edible cinema" experiences, or even at museums as art installations.

Sweetness was the easiest of the main five tastes to simulate, she says. "Bitter was the least recognised taste in our experiment, even though it is known as the most aversive of tastes – at the same time, it was also perceived as less unpleasant," Obrist said. "The underlying reasons require further investigation, and could be because of the levitation approach, the amount of stimulus, and delivery of droplets on the tongue."

Serious senses

What's the point of digital taste and smells? There are surprisingly practical applications, beyond a tech-savvy cocktail bar or a visit to a virtual restaurant in the metaverse. Digital sense tools could have serious use cases in healthcare, for example, by letting people with diabetes taste sugar without the negative impacts on their bodies.

"The spoon prototype, you could use for elderly people on sodium-restricted diets," Ranasinghe said. "Embedding the electrical stimulation into utensils that enhance the saltiness of the broth or porridge they are consuming is one of the latest projects we are working on."

Such high-tech spoons and forks could help all of us reduce sugar and sodium intake by making healthier food taste better digitally without the unhealthy additives. "In five or ten years'

Taste technologies could have a big part to play in the metaverse.

time, we could also create visionary scenarios where you will feel like you are eating steak or chocolate but it's actually broccoli," he predicted. "We can enhance the sensory pleasure related to food but consume healthier food... you can just drink plain water but feel like you are drinking something else, like a soft drink or cocktail."

Enhanced communication

Right now, online communications are focused on visual and audio input and output, though haptic feedback is used in gaming to an extent. What would the digital world look like if we could use all of our senses? "The application opportunities are diverse, and can range from augmented eating experiences, shared remote tasting, to novel gustatory interfaces that become part of our everyday interactions with and through technology," said Obrist.

As Ranasinghe notes, it's not just about replicating a cocktail in the metaverse or making VR feel more real, but using smell and taste to enhance emotional responses in digital experiences. "We associate sweetness with happiness and an unhappy, unpleasant situation with bitterness or sourness," he explained.

That said, it's easy to see taste technologies finding their way into virtual worlds. "In the metaverse, for example, imagine a scenario where a user walks into a virtual kitchen or restaurant and orders some food, and can taste and smell these foods using the capabilities of the head-mounted display," Ranasinghe said. "It's a completely viable scenario, but in terms of the hardware and delivery mechanisms, there are a lot of things we'd have to do [to make it work] as well as addressing the subjective nature of sensations."

Indeed, notes Ranasinghe, food comes with more than physical sensations from chemical reactions. "For example, if I eat fried chicken, the perception of that particular fried chicken for me is completely different from someone else based on our culture and food habits and genes and our environment – all of these things affect our flavour perception," he said. Because of this, more research is needed to understand how to make digital tastes and smells work for everyone consistently.

Inclusion is another reason to expand our understanding of digital senses beyond vision and hearing, adds Obrist. "Working in the field [of] human-computer interaction (HCI), I wanted to understand how we can harness the richness of sensory experiences when designing and developing new interfaces and technologies," she said. "Not only does that open up many more avenues for research on multisensory interfaces, but [it] may also create novel interaction modalities that are more inclusive, making use of all human senses, not just our eyes and ears and increasingly our sense of touch in the digital space."

Exactly what that would look like remains to be seen, but there's no question that the push into virtual worlds and metaverses – whatever they may look like in the end – will be more inclusive if there's a variety of ways to navigate them.

And then there's the idea of using smells and tastes to expand marketing with new senses to entice us, but it may not be as simple as advertising a burger with a meaty, greasy scent. Personalised ads may be annoying now, but they might really stink in the future – in an attempt to get your attention or impact your emotional state. And that could be far beyond stirring your appetite or evoking nostalgia.

"We do have to understand the impact on users' perception and ultimately behaviour and decision- making," said Obrist. "For example, we did an investigation on the effect of taste on risk-taking, and our findings suggest that sour consistently promotes risk-taking compared to other basic tastes – sweet, bitter, salty and umami. This could be relevant for gaming scenarios, but also for, let's say, ecommerce applications."

Time to taste TVs?

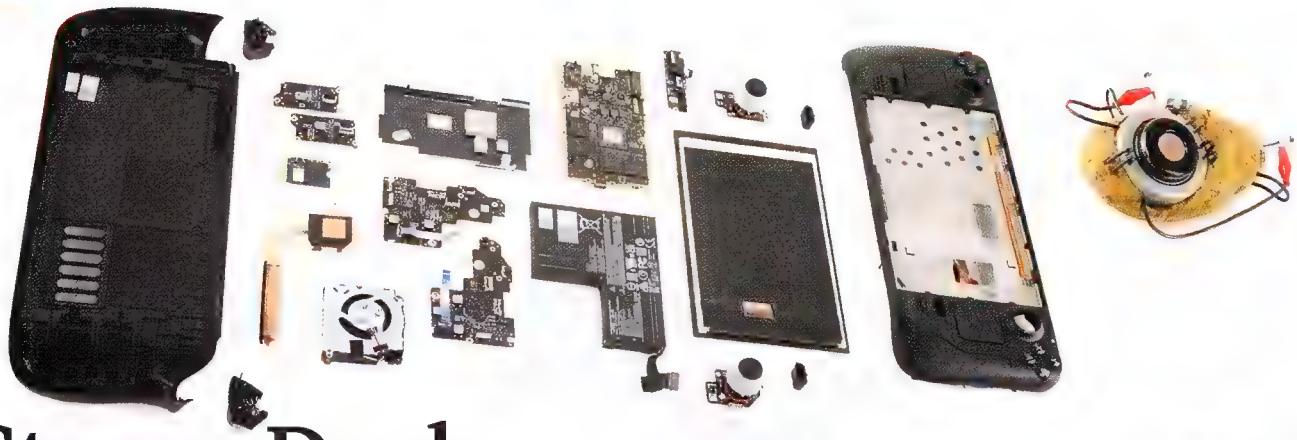
The predicted rise of virtual worlds means digital tastes and smells have clear applications, and beyond entertainment or marketing they could be useful in healthcare as well. But will anyone want to lick their TV for a virtual taste? Obrist says she would – if purely for academic research.

"As a researcher working on multisensory experiences, I would like to try the tastable TV demo and understand the taste experience – how does it taste [and] feel?" she said. "It is difficult to recreate taste experiences because they are more complex than just the taste and flavour sensation on your tongue; tasting and eating is a fusion of the senses."

In other words, there's much more to eating than the taste on your tongue, and that means that more work is needed in this area of research to bring such ideas into homes everywhere. "We first eat with our eyes, but then we are also exposed to countless sensory signals such as food textures, temperature and smells," she added. "The tastable TV demo is a great starting point to push current approaches and challenge mainstream thinking." And I have to admit, I'd be much more willing to sit through online ads if they tasted of chocolate. ■

HOW IT'S DONE

TAKING THINGS APART AND HAVING A POKE AROUND



Steam Deck

The hottest new device right now is the Steam Deck, a handheld gaming PC from Valve.

There have been other attempts to make a handheld PC games console, but none as high-profile or as cheap as Valve's Steam Deck.

Major tech specs

- AMD Zen 2 CPU with 4-cores/8-threads and a clock speed of 2.4–3.5GHz.
- AMD RDNA 2 GPU with 8 compute units and a clock speed of 1–1.6GHz.
- 16GB LPDDR5 RAM, with either 64GB eMMC, 256GB NVMe or 512GB NVMe SSD storage.
- 7-inch LCD touchscreen with 1280x800 pixel display and 60Hz refresh rate.
- 40Whr battery, USB-C port with charging and DisplayPort 1.4 support, Wi-Fi, Bluetooth, and 3.5mm audio jack.
- Dimensions: 11.7 x 4.6 x 1.8-inches (298 x 117 x 49mm), Weight: 669g.

Key findings

First of all, Valve should be applauded for offering this level of accessibility and upgradeability on its hardware. With just a little experience of PC building, you should be able to crack this thing open – though Valve warns that doing so will make the device more prone to drop damage. Valve has clearly labeled each internal component, which helps the repair process.

Easily replaceable items include the thumbsticks, storage, and motherboard items such as RAM. The battery and display aren't so easy. The battery could be the Steam Deck's Achilles' Heel – it lasts as little as 90 minutes playing demanding games, meaning you could be going through plenty of recharge cycles.

If there's one reason to open your Steam Deck, it's to upgrade the storage. But the microSD card slot is externally accessible, so you might want to try that first. If you do want to upgrade or replace the SSD, you can remove the M.2 2230 drive with a single screw. Just remember to reinstall the thin shield to prevent interference with the wireless receiver underneath.

The thumbsticks are held in with three screws each – loosen these and they come right out. No soldering is a big deal for hardcore gaming fans who may experience drift over time. Replacements should be available at some point in the future.

Battery replacement is tricky, even for seasoned hardware fixers. It's fiddly, requires specialist tools, and has the potential to damage your hardware. Drain the battery, then apply heat to soften the adhesive and pry it out. Isopropyl alcohol would make this easier, but any leaks could damage the display. The battery is an L-shaped model with two cells, like the iPhone X.

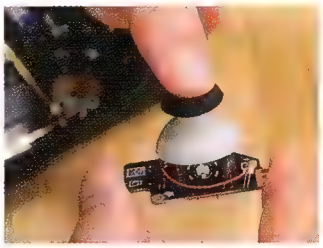
The screen is also tricky to replace but, hopefully, you won't need to. To do so, apply heat to the outside, apply a suction cup to the screen and use a plastic tool to make an incision in the adhesive under the bezel. The anti-glare etched glass coating makes it difficult for the suction cup to maintain a grip.

There are other minor gripes about upgradeability. The USB-C charging port and the microSD slot are both soldered to the main board – the former can get damaged over time, especially on a device that needs to be charged as frequently as this.

Repairability Score 7 out of 10 (10 is the easiest to repair).

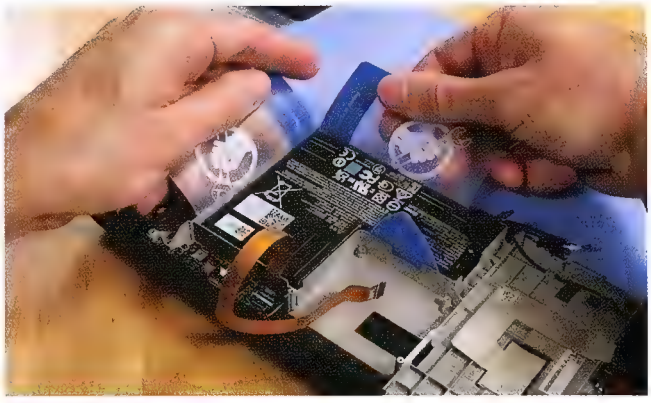
There are just eight Phillips screws holding the machine together.

Valve's repairability guides warn of danger when opening up the Steam Deck, but as long as you're sensible, you have nothing to worry about. Valve has prioritised the right components for repairability, such as the SSD drive and the thumbsticks. The real shocker is how difficult it is to repair the battery. However, props to Valve for giving every model of Steam Deck the same internal components – even if you opt for the budget model, you can still give it a substantial upgrade down the line. ■



Another big win for the Steam Deck – easy-to-replace thumbsticks.

The replaceable and upgradeable SSD feature is awesome.



Use heat to soften the adhesive and pry it out from the bottom edge – just watch out for the antenna hardware.

The A-List

THE BEST PRODUCTS ON THE MARKET, AS PICKED BY OUR EDITORS.
Find the best deals on new gear at **getprice.com/au**

PREMIUM LAPTOPS

Apple MacBook Pro 14in

Stunning creative power from $2,999

apple.com/au

Alongside its 16-inch sibling, this is simply the world's best laptop for demanding users. The amount of power on tap via the M1 Pro or M1 Max processor is staggering, and it's backed up by a terrific screen and stunning battery life. With all the ports you could ask for, the only negatives are its relative bulk (especially compared to the Air) and high price.

ALTERNATIVES

NEW ENTRY

LG Gram 17 (2021)
The combination of a 2,560 x 1,600 17-inch screen and 1.3kg weight – as well as a well-rounded specification – make this a great buy for homeworkers.
$2,998, lg.com

Apple MacBook Air
If you don't need the power of an M1 Pro or M1 Max, "make do" with the M1 in the MacBook Air and enjoy its super-slim design and relatively light weight at a much lower price.
From $1,499, apple.com/au

Asus Vivobook Pro 16X OLED
Top notch components, an amazing OLED display and leading battery life make this an exceptional Ultrabook for creatives.
$3,199
asus.com/au

BUSINESS LAPTOPS

Dynabook Portégé X30W-J

The best convertible money can buy

$2,369, asia.dynabook.com

Not only is this 2-in-1 convertible ludicrously light and slim, but it also offers a quiet keyboard, performance fireworks, ports a-plenty, a natural-feeling touchscreen and a battery that will see you through a busy working day. Dynabook by name, dynamite by nature.

ALTERNATIVES

Lenovo ThinkPad T14s
Solid, dependable and a pleasure to use, the powerful and slimline ThinkPad T14s includes a new Ryzen 7 Pro, as well as a super-plush keyboard.
$1,749, lenovo.com/au

Lenovo ThinkPad X1 Carbon Gen 9
A business laptop with heaps of luxury, especially if you choose the top-end model with a 3,840 x 2,400 screen.
$2,389, lenovo.com/au

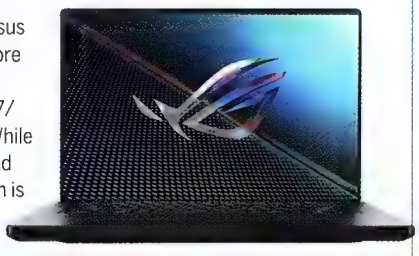
Dell XPS 13
Dell has updated the gorgeous XPS 13 with Intel's 11th-generation Core chips to great effect. The 13.4-inch screen, touchpad and solid keyboard are similarly sumptuous.
From $1,518, dell.com

GAMING LAPTOPS

Asus ROG Zephyrus M16 (2022)

i9-12900H and an RTX 3070Ti

asus.com



2022 will see an update for all mainstream gaming laptops, and Asus is first to jump in with a 12th gen Core i9 CPU to give 16-core support to the RTX 3070 Ti graphics (a Core i7/ RTX 3060 variant costs $2,999). While battery life is only average at around six hours, this laptop's final triumph is fitting a gorgeous 16-inch screen into such a compact chassis.

ALTERNATIVES

NEW ENTRY

Asus TUF Gaming A15 (2021)
The TUF Gaming A15 is a great choice if you need both power and portability, thanks to a Ryzen 7 5800H processor and RTX 3070 graphics.
$2,399, asus.com

Asus ROG Strix Scar 15 (2022)
A no-holds barred 15.6in laptop that gets the most from its i9-12900H CPU, RTX 3080 Ti,32GB of DDR5 RAM and 2TB SSD.
$5,299, asus.com

Asus ROG Strix Scar 17 (2022)
An RTX 3070 is the star, but it's backed by a high-quality 15.6-inch 165Hz screen, Ryzen 7 CPU and a solid aluminium chassis.
$2,299, asus.com

EVERYDAY LAPTOPS

Acer Swift 3X i7

Excellent performance at an appealing budget price.

acer.com

The headline feature of Acer's new Swift 3x is undoubtedly the fact that it features Intel's new discrete GPU – the Iris Xe Max Graphics. The Swift 3x is available exclusively through Harvey Norman as either an i7 with a 1T SSD, or a Core i5 model, with a 512GB SSD.

ALTERNATIVES

Lenovo Yoga Slim 7 Pro
A powerful, well designed ultrabook with an awesome OLED screen for a good price. The original 2-in-1 bends into a new clamshell shape.
$1,949, lenovo.com

HP Envy 13 (2020)
It may not be the world's most exciting laptop, but the Envy 13 is a compact and forward-looking machine that's ideally suited to these homeworking times.
$1,699, store.hp.com

Microsoft Surface Laptop Go
A superb travelling companion, the Go offers all the power you need in a stylish and well-built 1.1kg chassis.
128GB, $1,179 microsoft.com

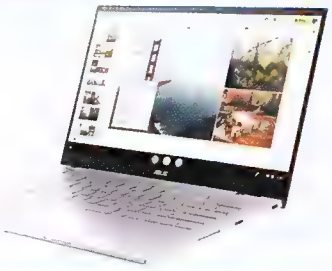
CHROMEBOOKS

Asus Chromebook Flip C436F

Flexible laptop for $1,419

amazon.com.au

The Flip C436F is a fast, flexible laptop with a slim magnesium alloy chassis that's easy on the eye. With a 256GB SSD, a Core i5 processor and fantastic 14-inch Full HD screen, it's a fine choice for demanding users.



Asus Chromebook CX9

Aimed squarely at business users, this exceptionally quick machine – with a Core i7 processor, 16GB of RAM and a 512GB SSD – drips quality throughout its aluminium alloy chassis. Add a glossy 4K 14-inch screen, plus a low weight of just 1.05kg, and it justifies its high price.

$1,579, asus.com

Lenovo IdeaPad Duet

The Chromebook answer to Microsoft's Surface tablets, this is a seriously versatile device – albeit not the speediest (although we never found it to be painfully slow while carrying out everyday tasks). For this price, and with a 16hrs 14mins battery life, the Duet is a great choice.

$447, lenovo.com

TABLETS

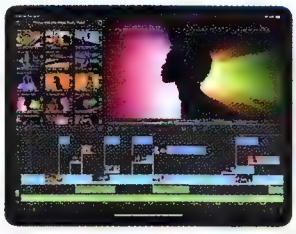
NEW ENTRY

Apple iPad Pro 12.9in (2021)

M1 power in your palm from $1,199

apple.com/au

Blurring the boundaries between laptop and tablet like never before, the M1-powered iPad Pro 12.9-inch is every bit as fast as we expected – and the "Liquid Retina XDR" display is simply phenomenal.



Apple iPad (2021)

Apple performs its usual trick of upgrading just enough to keep the iPad affordable and up to date, without treading on the toes of its more luxurious stablemates. The big bezels remain, but a faster processor, more storage and improved camera all add to its appeal.

From $449, apple.com/au

Samsung Galaxy S8 Ultra

The Samsung Galaxy Tab S8 Ultra is an enormously impressive tablet. It makes a fantastic first impression with its gorgeous screen and thin body, and is great for multitasking. If you want the best Android tablet going, there's no question at all that this is it.

$1,598, samsung.com

EVERYDAY MONITORS

Philips Brilliance 346P1C

34-inch curved docking, $849

philips.com.au

No-one can match Philips for its mix of quality, features and value, especially when it comes to curved MVA monitors such as this. It's great for casual gamers and busy workers alike, with USB-C docking and superb colours.

Eizo FlexScan EV2480

Businesses in particular will love this easy-to-roll-out 24-inch monitor, with its exceptional five-year warranty, USB-C port for easy docking, excellent viewing angles and delicious whites. And it has the best OSD around.

$699, eizoglobal.com

Dahua DHI-LM28-F420

This affordable 4K monitor might not offer much in the way of menu options or high-end gaming perks, but it offers impressive resolution and colour for a fraction of the price you'd normally pay.

$269, dahuaaustralia.com.au

PROFESSIONAL MONITORS

Eizo ColorEdge CG319X

Creative masterclass, $7,119

eizoglobal.com

As the price indicates, this monitor is for heavyweight creatives who demand the best in every discipline: HDR video editing, print layouts, professional photography and more besides. With superb coverage and accuracy across all spaces, plus a built-in calibrator, it justifies the investment.

BenQ PD2725U

By no means a cheap 4K 27-inch monitor – unless you compare it to the Eizos – but it marries all-round quality with ease of use thanks to a puck that allows you to quickly move between settings. You can even daisy chain a second Thunderbolt 3 monitor for a monster setup.

$1,799, benq.com

Eizo ColorEdge CG279X

Designers who need to work across different disciplines will love how easy it is to switch between the Adobe RGB, DCI-P3 and sRGB colour spaces using the Eizo's fantastic OSD. It's certainly not cheap for a 27-inch 1440p monitor, but it's packed with quality.

$3,095, eizoglobal.com

HOME OFFICE PRINTERS

Epson EcoTank ET-1810

Back to basics

$299, epson.com.au

There's nothing flashy about this bottle-fed inkjet: it's there to churn out pages at a decent rate (8.8ppm for black text) for a low price. It comes with enough ink for 4,500 black pages and 7,500 in colour, but refills are cheap. Just don't expect features like duplex printing.

Canon Pixma Pro-200

Yes, it's big and it's expensive – and you don't even get a scanner – but the Pixma Pro-200 means that you can print A3 photos with glorious colour accuracy and detail. If you're after an office workhorse, look elsewhere, but it can't be beaten on photo quality.

$809, canon.com

Brother MFC-J4540DWXL

Home workers will love this inkjet all-in-one. It combines an incredible range of features with all the connectivity you need and extreme ease of use. Output quality is fine, it offers the best cloud support around and the high-capacity ink pack could keep you going for years.

$420, brother.com

WIRELESS ROUTERS

Asus Zen Wifi XD6

Winning Wi-Fi 6 performance, $699

asus.com

Asus continues to refine its Zen Wi-Fi 'megamesh' routers (two nodes with a dedicated backhaul channel) and, with the XD6, produced the fastest overall router we've ever tested.

Asus RT-AX82U

The impressive RT-AX82U punches well above its price when it comes to raw Wi-Fi 6 performance and includes a fistful of useful features – such as an ultrafast 20Gbits/sec USB connector, outbound VPN support, site-blocking and a host of parental controls. **$320, asus.com**

Huawei WS7200

This affordable Wi-Fi 6 router delivers consistently fast wireless speeds, broad coverage and a modest speed boost for newer hardware – and the Router 3 has a cute design too. If you need more range, you can pick up a second unit to use as an extender.

$120, huawei.com

MESH WI-FI

Netgear Orbi RBK752

Wide Wi-Fi 6 mesh, $669

netgear.com.au

More expensive rivals may boast better performance, more connections and a more impressive selection of features, but the user- friendly Orbi RBK752 offers unimpeachable mesh coverage for the price.

TP-Link Deco X20

The price below isn't a typo: the Deco X20 makes it possible to upgrade your home network to Wi-Fi 6 – as well as manage its security – for the price of some standalone routers. The included HomeCare functions are also a great bonus for households where lots of devices are fighting over the bandwidth.

$199, tp-link.com

Asus ZenWiFi AX

The interface and design certainly aren't the prettiest (the nodes look like mini space heaters, while the charcoal version is straight out of the 1980s), but if you're after strong performance, great features and plenty of expansion potential, the ZenWiFi AX is a compelling prospect.

$949, asus.com

NAS SERVERS

NEW ENTRY

QNAP TS-130

Simple home NAS, $250

qnap.com

An above average CPU and RAM combo, solid features and affordable price make the QNAP TS-130 worth considering. Alternatively there's the two bay TS230 which features the same CPU, with 2GB of RAM, dual drive bays, and an extra USB port on the front for a modest $50 price increase.

Asustor Nimbustor AS5304T

This is a hugely powerful four-bay NAS that will be overkill for most people – not just due to its speed but also its slightly intimidating user interface – but techies and gamers should investigate the Nimbustor AS5304T for both its speed and flexibility.

$799, asustor.com

Synology DS1019+

This five-bay NAS includes many of the features that make the DS218+ to the left such an attractive buy: a superb selection of apps, an elegant hardware design and a good deal of power. And those five bays make it perfect for RAID5 configurations, or Synology's own Hybrid RAID.

$1,249, synology.com

SECURITY SOFTWARE

F-Secure Safe

F-Secure concentrates on the basics: faultless protection with minimal impact on your system's performance – for a low price.

1-3 PCs, 1yr, $99.99, f-secure.com

Kaspersky Internet Security

With plenty of tools and features to play with, the powerful Kaspersky Internet Security goes a long way beyond blocking viruses. **1 PC, 1yr, $41.95, kaspersky.com.au**

Avast Free Antivirus

For the second year running, Avast is our top pick for free antivirus software – it's simply lighter on its feet than Microsoft Windows Security, whilst offering fewer false positives.

Free, avast.com

VPNs

NordVPN

NordVPN provides consistent and fast speeds, serious security, great support for video-streaming services and some cost-effective subscription rates.

$59 per year, nordvpn.com

ProtonVPN

ProtonVPN provided one of the best free offerings of all the VPNs in our group test, including unlimited data, but upgrade to benefit from even faster speeds and many more options.

Free, protonvpn.com

Surfshark

A strong rival to NordVPN, especially if you're willing to commit to its two-year contract. It's fast, cheap and a fine choice for people who like to switch to US streaming services. **$66.34 for one year, surfshark.com**

PASSWORD MANAGERS

Bitwarden

Bitwarden has a huge advantage: it's free. It isn't as slick as some paid-for rivals, but it can sync passwords across all devices for no extra charge.

Free, bitwarden.com

Dashlane

A manager that's ideal for beginners, and it even builds in an unlimited (if basic) VPN service. Note you may prefer to buy the Family plan ($60 per year) as this extends the service to six people.

$55.99 per year (Premium), dashlane.com

1Password

1Password is targeted at technically minded users who are looking for the last word in security. It even offers a Travel Mode that may ease your mind if surrendering your phone to customs officials.

$54.99 per year (individual), 1password.com

The top microphones

06

BLUE YETI NANO

For great audio without all the bells and whistles, Blue has you covered with the Yeti Nano. The brand of choice for professional podcasters, Blue's latest mic has a smaller footprint than the original Yeti, fewer recording options (cardioid and omnidirectional), and a plastic finish. However, it has enough features for the majority of podcasters, streamers, and musicians. **$125 bluemic.com**

03

AVERMEDIA LIVE STREAMER MIC 330

This microphone is ideal for live streamers and podcasters. Its XLR connection means you can pair it with a mixing deck, such as AVerMedia's Live Streamer AX310. This Cardioid mic does an excellent job of picking up what's in front of it, though it doesn't boast fancy lighting or omnidirectional recording.
$149 avermedia.com

05

NZXT CAPSULE MIC

This microphone has a quick-release stand, making it ideal for recording on-the-go. It's stylish, well made, and easy to get up and running. There's a USB-C connection on the bottom of the mic, plus an easily-accessible mute button and a light ring that lets you see when you're broadcasting. However, it only records cardioid (front of mic), so it's not ideal for interviews.
$189 nzxt.com

02

MSI IMMERSE GV60

MSI's gaming peripherals tend to be unassuming, well made, and priced competitively. The GV60 carries on that tradition with all the features you'd want at this price. The front houses the controls, including four different audio pickup styles, mic and audio balancing, and a mute button. It also uses USB-C connectivity, while the package includes a pop filter for clearer sound.
$189 msi.com/Gaming-Gear

04

ELGATO WAVE:3

Elgato is no stranger to premium gaming accessories, and the Wave:3 is beautifully made, but more expensive than its rivals. The flat design saves space, it connects via USB-C cable, and the lighting on the front of the mic lets you see audio levels and whether you're muted. However, it only does Cardioid recording, there's no RGB lighting, and you have to buy the shock mount separately.
$209 elgato.com

01

HYPERX QUADCAST

HyperX's mic boasts sturdy construction and is easy to mount, either in the included desk stand or on a mic arm. There are four audio pickup modes including omnidirectional, and it looks great thanks to sleek red lighting that indicates when you're recording. A touch-sensitive mute button allows quick and easy privacy.
$219 hyperxgaming.com

GADGETS

NICE LITTLE THINGS

$TBC | segway.com

Segway Shredder

You now don't have to look like a nonce when riding a Segway.

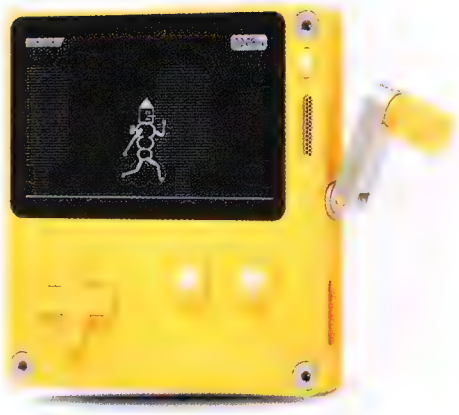
Ok so the name might sound like it was yelled by a sales rep aiming to emulate Steve Ballmer's enthusiasm for 'developers', but the Shredder is definitely less dorky than your average traditional Segway product. The four wheeled scooter offers enough stability for the least outdoorsy coders to jump on and rip without any practice. When you do feel like the Shredder's four wheels have become another one of your bionic appendages, you can detach the steering shaft to make it an electric skateboard. This slick setup can reach top speeds of 23 or 37km/h depending on which Ninebot wheels you pair it with.

US$65 | kck.st/3wM6EkG

ELECTRON VIRTUAL REALITY FOR SWITCH

Transform your Switch into an immersive headset.

One ambitious Kickstarter wants to turn Nintendo's current handheld console into a face-held VR unit. While the Nintendo Switch isn't going to offer the same QuadHD resolutions and fast AMOLED refresh rates of the top VR compatible smartphones, what the 1280 by 720 pixel screen lacks in fidelity it makes up for with a custom Nvidia Tegra GPU. This extra GPU power means you'll be able to play a bunch of Nintendo games in VR and you can use the additional battery power to get close to four hours of battery time. You can even use the existing switch controllers.



US$179 | play.date

PLAYDATE

A new e-Ink GameBoy with a twist.

It's not every day that you get an entirely new device to play with, or even a new game for that matter, but the software studio behind *Firewatch* and *Untitled Goose Game* have created a novel handheld gaming console that delivers you fresh indie games every week. Playdate is part GameBoy, part Etch A Sketch, and part crank. It's got all the familiar A and B buttons and a predictable D-Pad, but it also comes with a twist – well technically a crank – that you use to interact with a heap of new games that are uploaded to the device every week.

M8 $1,199; M7 $699; M5 $499 | samsung.com

SAMSUNG M8 AND M7 SMART MONITORS

Samsung reckons your living room PC could make a pretty great monitor.

Samsung's got a new range of desktop computer monitors that include Tizen Smart TV software and remote controls to allow them to double as a living room entertainment screen. The M7 comes in 32- or 43-inch sizes, both with 4K resolution, and cost $699 and $899 respectively. Samsung is also offering a $1,199 32-inch Smart Monitor M8 that comes with a more space conscious base, a slightly brighter 400nit 4K screen, a sleek webcam and dynamic HDR10+ colour specification. If your budget is a tad lower then there is a 32-inch Smart Monitor M5 option for $499 that comes with a 250nit 1080p screen.

US$650 | vava.com

VAVA 100-IN ALR PROJECTOR SCREEN

Get rid of unwanted projector background light.

Many still regard the projector as the best way to watch cinema, but most people just don't have a spare darkroom to get the best picture quality from them. If you're mainly contending with downlights then an ambient light rejecting screen has the potential to dramatically improve the picture quality of your short throw projector, but locally these screens often cost about the same as the largest TVs on the market. At US$650 the VAVA ALR 100-inch projector screen requires a little bit of DIY construction, but it's a much more approachable way of getting a high fidelity cinema setup in conventionally lit rooms.

$6,995 | recess.com.au

THE NOOK

Your personal space.

When you need to find some quiet time to actually get stuff done, a bustling open plan office or a WFH situation with kid noise and distractions are your enemy. Enter the Nook. Literally. This personal workspace is a standing or stool-seated micro-office and has power and USB charging, is well ventilated and insulates you from noise. The price includes installation, and it can be broken down and relocated without too much trouble. They're extremely popular in rented office spaces for good reason. The Nook might be a bit tight for nooky, but it's great for all your other business.

$3,199 | asus.com/au

Asus Vivobook Pro 16X OLED

Asus's new AMD-powered Vivobook may just be the MacBook Pro killer we've been waiting for.

Asus' Vivobook range has often catered to the more financially savvy premium ultrabook consumers, but the Vivobook Pro OLED series is looking to change this presumption with powerful thin and light offerings with OLED displays. Even these days, OLED screens are not exactly commonplace, so we're still surprised every time we see the colours they're capable of reproducing, and the Asus Vivobook Pro 16X OLED is one of the better OLED panels we've seen.

The 16-inch panel offers 4K resolution in a 16 x 10 format with Vesa True Black 500 HDR colour. While this is a pretty amazing feature set offering a 1-million-to-one contrast ratio, it actually sets the bar higher by meeting 100 percent of the DCI-P3 colour gamut and includes an unprecedented 0.2ms response rate on the 60Hz panel. This amounts to a generously sized display capable of accurate professional colour work and detailed creative workflows. It also looks pretty amazing for media playback and will bring to life any games you might want to fire up on it.

This impressive screen is backed up by one of the top AMD Ryzen 9 5900HX CPUs, a solid 16GB RAM allocation, and an Nvidia GeForce RTX 3050 Ti GPU. That CPU was one of the best performing processors in 2021 and when paired with a 3050 Ti offers above average Ultrabook performance that'll be capable of running demanding software with ease. Against a Microsoft Surface Studio Laptop with an Intel Core i7-11370H CPU, the Vivobook Pro 16X OLED offered more than twice the performance in processor heavy benchmarks, something that's explained by it offering eight processor cores, over the four used by the i7.

When paired with a 1TB SSD the Vivobook Pro 16X OLED comes in at $3,199, which means it competes directly with devices like the Surface Studio Laptop and undercuts the MacBook Pro 16 (M1 Pro) by $550. In CPU heavy tasks it's not quite where the MacBook Pro 16 is, but the 3050 Ti offers meaningful performance improvement over the M1 Pro 16-core GPU so it's pretty comparable on the whole. If you do happen to want to game you'll be able to get over 45fps using 1080p Ultra settings on current titles, which should be just enough to play less demanding games in 4K on lower graphics settings or using Deep Learning Super Sampling technologies.

The generous 96Wh battery offers over 10 hours and 30 minutes in general work tasks and media playback when the screen is at 50 percent brightness, which means you'll get a full day unless you're gaming or really stressing the system. This is an hour and a half more than what we got on the MacBook Pro 16 and is up there with the longest lasting laptops with high res screens.

Asus has also invested a lot in additional features like a nifty DialPad for creative power users, a fingerprint reader, webcam shutter, low blue light software, and a noise-cancelling microphone, to ensure you're able to make the most of this device in any work environment.

There's enough interface options and the trackpad and keyboard are comfortable to use, so we can't see any reason why you wouldn't want this laptop.

Specifications
Windows 11 Pro; 16-inch OLED display at 3840 by 2400 pixel resolution; AMD Ryzen 9 5900HX CPU; Nvidia GeForce RTX 3050 Ti GPU; 16GB RAM; Vesa HDR True Black 500, 100% DCI-P3; 1TB SSD; 96Wh battery (10h 36min 1080p movie playback); 36 x 25.9 x 1.9cm; 1.95kg.

This impressive screen is backed up by one of the top AMD Ryzen 9 5900HX CPUs, a solid 16GB RAM allocation and a Nvidia GeForce RTX 3050 Ti GPU

	ASUS Vivobook Pro 16X OLED	Apple MacBook Pro 14 M1 Pro
Geekbench 5 - Multi-core (score)	8,256	12,525
Cinebench R23 - CPU (multi-threaded)	11,978	12,372
Geekbench 5 - Open CL (score)	62,098	37,120
Sid Meier's: Civilization VI - 1080p Ultra (fps)	77	50
Battery life - 1080p video playback (h:min)	10:36	15:00
Peak CPU temperature (°C)	93	DNT
CrystalDiskMark Read (MB/s)	3,579	5,662
CrystalDiskMark Write (MB/s)	3,013	5,077

Top notch components, an amazing OLED display and leading battery life make this an exceptional Ultrabook for creatives.

Joel Burgess

★★★★★

From: $3,849 | au.msi.com

MSI Raider GE76

Did this Raider just steal the laptop CPU crown back for Intel?

It was a close competition last year between Intel's i9-11980HK, AMD's Ryzen 9 5900HX, and Apple's M1 Max 10-core processor for the fastest laptop CPU, so we're not overly surprised that Intel was keen to get MSI's new Raider GE76, with a 12th Gen i9, over to us for testing as soon as it could.

We've tested Intel's 12900KF desktop i9 processor and even the Intel Core i9-12900H on a thermally constrained gaming tablet already this year, but this is our first exposure to the unlocked Intel Core i9-12900HK workstation CPU – and first impressions are great.

The i9-12900HK shows performance bumps of between nine and 37 percent over last year's i9-11980HK on various benchmarks, an improvement that is likely due to the adoption of an Apple-like arrangement of six performance cores and eight efficiency cores. The updated processors offer a total of 20 hyperthreads running at the same 5GHz max turbo frequency (for anyone who isn't an overclocking wizard) as its predecessors, which puts this chip at the top of our laptop processor performance list.

The GE76 has long been MSI's 17-inch gaming flagship designed for those that want a no-compromise gaming experience on-the-go and this year's iteration is no different. While the model we looked at featured the 12th Gen i9, the range starts with a 12th Gen i7, 16GB of RAM and a Nvidia 3070Ti GPU for $3,849, but you can configure them all the way up to an i9, with 32GB of RAM and a Nvidia 3080Ti, if you're happy to drop $7,199.

In addition to deciding which of the ultra premium components you'd like, there's also a few choices of screen ranging from a 120Hz 4K monitor with DCI-P3 colour to the 360Hz FullHD IPS panel for professional-level high refresh rate gaming. MSI sells different screen and component combos to different vendors so make sure you looking at the same unit when comparing sales outlets.

Specifications
W11 Home; 17.3-inch 360Hz IPS display at 1920x1080 pixel resolution; Intel Core i9-12900HK CPU; Nvidia GeForce GTX 3070 Ti; 32GB RAM; 1TB SSD; 96Wh battery (6h6min 1080p movie playback); 39.7 x 28.4 x 2.6cm; 2.9kg.

The GE76 has long been MSI's 17-inch gaming flagship designed for those that want a no-compromise gaming experience on-the-go and this year's iteration is no different.

	MSI GE76 Raider (2022)	MSI GE76 Raider (2021)
PCMark 10 - Overall (score)	7618	6,974
Max CPU Temperature (C)	99	100
1080p movie playback (HH:MM)	06:06	05:21
Cinebench R23 - CPU (Score)	17148	11922
3DMark Time Spy (score)	11,247	11,188
The Division 2 - 1080p Ultra (fps Av.)	102	111
CrystalDiskMark Read (MB/s)	6,584	6,698
CrystalDiskMark Write (MB/s)	5,085	5,032

The model we tested came with a Nvidia 3070 Ti GPU, which offered impressive gaming performance with averages of over 100fps on most titles using 1080p Ultra settings, so you shouldn't have any issues running games full tilt whichever screen and GPU combo you choose.

Of course you can expect full RGB per-key backlighting from the SteelSeries gaming keyboard, and the footprint and 2.9kg weight is identical to its predecessor, so there's not much in the way of surprises here.

Battery life was pretty good for a gaming laptop lasting between five and si hours under general non-gaming conditions. There's plenty of ports and the fans aren't too loud so there's not too much in the way of downsides, but there's nothing overly dramatic differentiating this one from the competition.

An extremely powerful gaming laptop with variations to fit a range of budgets.

Joel Burgess

★★★★½

$1,699 | online.acer.com.au

Acer Enduro Urban N3

Acer brings rugged work laptops to the outdoorsy consumer.

The Enduro Urban N3 is not your average laptop. It's the kind of device that has IP53 splash resistance so you can take on a hike without being worried that you'll get rained on. It also includes MIL-STD 810H resistance certifications and reinforced corners so it'll survive a drop or two when you're out on a bike.

An above average 450nit display makes it easier to see the 14-inch display when outside in the sun and it's even got an antimicrobial coating to help maintain health in challenging environments. The Enduro Urban N3 is a laptop that is able to adapt to its surroundings, meaning you can have the functionality of a modern device wherever you need it.

All this versatility wouldn't be that useful if you didn't start with a solid set of computing components. The foundational Acer Enduro Urban N3 model comes with an Intel Core i5-1135G7 processor, 8GB of RAM and a 256GB SSD, for an RRP of $1,899. These are reasonable components that'll allow most people to reliably perform lighter workloads using office documents and web pages, but even at the sale price of $1,699 you could find non-ruggedised laptops with similar components for hundreds less.

If you do need a little more oomph, then the Enduro Urban N3 also comes in a variation with an i7-1165G7 CPU, 16GB of RAM and a 512GB SSD for an RRP of $2,299. We couldn't actually find this one available anywhere locally at the time of writing, but if it does become available, it'll again allow users to push a little further into more demanding creative and processor heavy workloads.

While it might be a cut above your average laptop at battling the elements, this advantage does come at a cost. The most obvious is the plastic exterior, which Acer has designed to fit in with your cargo shorts or a windbreaker, but it still isn't as sleek as the polished metal finishes you get on standard ultrabooks.

Despite this lightweight plastic chassis the Enduro Urban N3 weighs 1.85kg, 30 to 40 percent heavier than many ultraportable laptops, and with a thickness of 2.2cm it's got as much girth as many of today's gaming laptops.

The other limiting factor is that you'll have to unclip the waterproof caps every time you want to connect something. For anyone that requires waterproofing, then this is an negligible tradeoff, but it'll get a bit tedious if you're regularly connecting various other devices.

The keyboard is good, but the trackpad is a little grippy and the trackpad buttons are mushy and imprecise. The screen also has chunky bezels and can be a little glossy for bright background environments.

If you really need something that can hold its own in dusty, wet, or cold environments then there is a heap of tech on the Enduro Urban N3 that'll keep things running way longer than your average Ultrabook. If you don't need these features, however, then you can find thinner, lighter and cheaper devices pretty easily.

Specifications
Windows 10 Pro; 14-inch IPS display at 1920 x 1080 pixel resolution; Intel Core i5-1135G7 CPU; 8GB RAM; Intel Iris Xe Graphics; 256GB SSD; 48Wh battery (6h23min 1080p movie playback); 35.1 x 24.5 x 2.2cm; 1.85kg.

The Enduro Urban N3 is a laptop that is able to adapt to its surroundings to mean you can have the functionality of a modern device wherever you need it.

	Enduro Urban N3	Acer Swift 3X
PCMark 10 - Overall (score)	4,954	5,155
Cinebench R23 - CPU (multi-threaded)	5,454	6,178
Geekbench 5 - Multi-core (score)	4,235	5,293
3DMark Time Spy (score)	1,278	2,049
Battery life - 1080p video playback (h:min)	06:23	03:07
Peak CPU temperature (°C)	100	96
CrystalDiskMark Read (MB/s)	3,558	2,232
CrystalDiskMark Write (MB/s)	2,996	1,972

A tough 14-inch laptop for working in challenging outdoor environments.

Joel Burgess

★★★★☆

$649 | www.amd.com

AMD Ryzen 7 5800X3D

A technological marvel designed for gamers.

You might be forgiven for assuming the Ryzen 7 5800X3D is a simple refresh of the highly regarded 5800X, but that's doing it a disservice. There's a lot more to it. The 3D part of the name might give a hint. The 5800X3D incorporates 64MB of L3 cache stacked on top of the CPU die. That means it has 96MB of cache vs the 5800X's 32MB. It really is an amazing bit of design and manufacturing. It gives us a glimpse into the future of semiconductor manufacturing.

The 5800X3D is a Zen 3 based processor featuring a single core complex with eight cores and 16 threads. It has a base frequency of 3.4GHz and a boost frequency of 4.5GHz with a 105W TDP. But that extra cache consumes power, which means the frequencies of the 5800X3D are 400MHz and 200MHz lower than the base and boost clocks of the 5800X. That means that in apps that are not sensitive to all that cache, the X3D chip will be slower. But apps that are cache sensitive include games. A fast gaming CPU sells, and generates headlines. Apart from being a test vehicle for vertically stacked cache, AMD touts the 5800X3D as the world's fastest gaming CPU.

The 5800X3D is compatible with existing 400- and 500-series AM4 motherboards. That makes it a very cost-effective upgrade when you consider the higher cost of buying an Intel system with the cost of a motherboard and possibly DDR5 memory as well. In fact AMD may release BIOS code to add compatibility to 300-series motherboards. That means if you're running a 2000- or 3000-series Ryzen processor, the 5800X3D would make one heck of an upgrade for gaming and everything else too.

Now we come to performance. The 5800X3D is faster overall at gaming than the 12900K, though not in every case. In a GPU-limited game like *Metro: Exodus Enhanced Edition*, the 5800X3D is ahead. The differences become more apparent as the game becomes more CPU limited, which is something that gamers with very high refresh rate monitors should note.

It's not all rosy though. In productivity apps, the 5800X3D falls behind the 5800X due to its lower clock speeds. It's also demanding on cooling, running almost the same load temperatures as a 5800X despite its lower clocks. On the plus side, it used around 15W less power than the 5800X. There's also no overclocking. With such bleeding edge tech we can understand that. Never say never though.

The 5800X3D is a very interesting CPU. If you're using the AM4 platform and are looking to upgrade to a 5000-series processor for gaming, it's an awesome chip and highly recommended. But, it's not for everyone. If you're already using a 500-series processor, the gains are minimal, if not a slight step back compared to a 5800X. AMD claimed the 5800X3D was a gaming-oriented processor, and it has succeeded in achieving its goal.

It leaves us very excited for future Zen 4 processors. If Zen 4 brings higher clocks along with architectural benefits then AMD is all set to have a very competitive CPU range on its hands. We can't wait to see how it will use its vertical stacking technology in the future.

Specifications
Socket AM4; 8-core/16-thread; 3.4GHz base/4.5GHz boost clock; 96MB L3 cache; Supports DDR4-3200; 105W TDP.

		AMD Ryzen 7 5800X3D	AMD Ryzen 7 5800X	Intel Core i9-12900K
Handbrake 1.4.2 - Video conversion 4K to 1080p FPS		54.6	56.1	84.9
Cinebench R23	Rendering - Multi thread Score	14,961	15,588	27,119
	Rendering - Single thread Score	1,496	1,593	2,008
3DMark TimeSpy Extreme	Overall score	9,067	9,234	10,076
	CPU Score	5,520	5,715	8,972
Ghost Recon: Breakpoint - 1080p, Low, Avg FPS		235	217	231
Metro: Exodus Enhanced Edition	1080p, Ultra, DX12, Avg FPS	135.4	129.1	133.1
	1080p, Ultra, DX12, Min FPS	77.8	77.5	76.5
Middle Earth: Shadow Of War - 1080p, Lowest Preset, Avg FPS		389	309	365

The 5800X3D is a great showcase for AMD's V-cache tech. It's a fantastic gaming processor, though it's not for everyone.

Chris Szewczyk

★★★★☆

$3,459 | www.asus.com

Asus TUF Gaming GeForce RTX 3090 Ti OC

Meet the most powerful GPU on the market.

It's nearing two years since the RTX 30-series made its debut in September of 2020. The Ampere series has been a roaring success for Nvidia, and now we come to the best and perhaps last Ampere generation card before the launch of the Ada Lovelace range later in 2022. The RTX 3090 Ti is fast and powerful, but with a price nearing $3.5K, it's definitely a niche product.

The RTX 3090 Ti uses the fully enabled GA102 GPU, the same one used by the RTX 3080, 3080 Ti, and 3090. It comes with 10,752 cores, a 384-bit memory bus and 24GB of 21Gbps memory for 1,008GB/s of memory bandwidth. On top of that, the card comes with a huge 450W TDP, which means Nvidia is really pushing the limits of the architecture, and power efficiency is poor compared to the lesser GA102 cards. 3090 Ti's come with the new 12+4pin 12VHPWR PCIe 5.0 power connector. Many, like the Asus TUF we've got on hand. include a three 8-pin to 12VHPWR adapter.

The Asus TUF 3090 Ti is an absolute monster of a card. It comes with a 3.2-slot cooler (four slots in reality) that's well suited to the high TDP of the 3090 Ti. It comes with dual BIOS and you get triple DP 1.4a and dual HDMI 2.1 ports. That extra HDMI port will come in handy for some users. There's a full cover backplate and the build quality of the card is excellent, though you'd expect nothing less of a card that costs nearly $3,500!

Specifications
10752 Shader Units; 1560MHz Base Clock, 1950MHz Boost Clock (OC mode); 24GB GDDR6X 21Gbps memory, 1,008GB/s Memory Bandwidth; 3x DisplayPort 1.4a, 2x HDMI 2.1; 1x 16-Pin Power Connector, 450W TDP.

What really matters is how it performs. The short version is that the 3090 Ti is the fastest graphics card you can buy. It beats out the 6900XT in all games except those that are heavily tuned towards RDNA2. If we compare it to an MSI RTX 3080, we see it ahead, but is a 15 to 20 percent performance gain worth over $1,500 more? That's a question that's relevant to every flagship card, and the answer is up to you as you balance your needs and wants.

The card consumes a lot of power. We recorded 454W for the card alone; that's nearly 100W more than a 3080 Ti Founders Edition. However, despite its power consumption, the card ran surprisingly cool, which is a testament to the excellent TUF cooler. A load temperature of 70c is outstanding. Rumours suggest that 3090 Ti PCBs and coolers can be used with next gen GPUs, so if a 4090 consumes well over 500W, the Asus cooler should be able to handle it.

What are we to make of the 3090 Ti? To the majority of gamers, it's utterly irrelevant. But as a halo product and technological showcase, it serves its purpose. It's fast, powerful (in more ways than one), and it's absolutely desirable.

The 3090 Ti's 4K performance along with Ampere's impressive ray tracing and particularly DLSS tech deliver amazing performance, but its poor power efficiency is a worrying sign of things to come. Its price means it's a card that many will want, yet few can afford or justify. A year ago, we would have been more impressed, but potential buyers of this card probably have their eyes on next gen cards that are due in a few months' time.

		Asus GeForce RTX 3090 Ti TUF Gaming	AMD Radeon RX 6900 XT	MSI GeForce RTX 3080 Gaming X Trio
Metro: Exodus Enhanced Edition	2560x1440 Ultra Preset - Avg	[illegible]	77.2	81.3
	3840x2160 Ultra Preset - Avg	[illegible]	43.9	50.6
F1 2021	2560x1440 Ultra High Preset - Avg	[illegible]	165	145
	3840x2160 Ultra High Preset - Avg	[illegible]	104	87
Far Cry 6	2560x1440 Ultra Preset - Avg	[illegible]	119	118
	3840x2160 Ultra Preset - Avg	[illegible]	83	77
Ghost Recon Breakpoint	2560x1440 Ultimate Preset - Avg	[illegible]	111	106
	3840x2160 Ulitimate Preset - Avg	[illegible]	73	71
3DMark Time Spy Extreme	Overall Score	[illegible]	8,651	8,246

The RTX 3090 Ti is a supremely powerful GPU, but it has limited appeal over the likes of the 3080 Ti and 3090.

Chris Szewczyk

★★★½☆

$49 | www.deepcool.com

DeepCool AK400

A $49 CPU cooler that promises to be a big step up from bundled stock coolers.

It's important not to overlook air cooling. Manufacturers love to sell you expensive closed loop water coolers, but they're overkill for a lot of users. Not everyone buys a high TDP CPU, though even if you do, you might be surprised at how a cooler like the DeepCool AK400 will handle it. The AK400 is a low-cost single tower cooler that can dissipate up to 220W, making it a capable option for all but the hottest modern desktop CPUs.

DeepCool has a reputation for delivering excellent coolers at affordable prices, and the AK400 is priced at just $49! There aren't many good quality 120mm class coolers at that price point, so the AK400 already has an advantage.

The AK400 aims to keep things simple. You don't get HEDT support and AMD support is limited to the AM4 socket. Intel's LGA 1700, 1200, and 115x sockets are supported. That's fine by us. It covers the majority of users who are likely to be in the market for a new cooler. Its 220W TDP is high for a single tower, and it's an indicator that DeepCool is confident in its engineering.

The AK400 features four direct contact copper heatpipes that connect to a single aluminium tower. From the base to the top, the total height is 155mm, while its 73mm width including the fan means it's easily able to be used in systems with tall RAM heatsinks. The base is quite small, barely covering the heatspreader of our Ryzen 5800X test CPU. But if it works, it works!

Specifications
DeepCool AK400 Black CPU cooler; up to 220W TDP cooling capability; AMD AM4, Intel 1700, 1200 and 115x compatible; 1x FC120P 120mm FDB fan; Up to 29 dB(A) Noise Level; 3 Year Warranty.

The single included fan is a fluid dynamic bearing model with a 50,000-hour operational lifespan. Its maximum noise level is said to be less than 29 dB(A) at up to 1,850 RPM. That's a quiet rating. The fan, and the heatsink itself are free of RGB lighting. DeepCool includes a set of clips for installing a second 120mm fan.

Installation is straightforward. You get a backplate for Intel motherboards, while for AMD users, you can use the standard AM4 backplate. Just remove the plastic clips, attach the spacers and mounting plate and all that's left is attaching the heatsink itself. With an AMD system, it can only be installed blowing air towards a rear I/O fan. DeepCool suggests Intel users should mount it the same way.

So, how does it perform? In a closed case, we saw a maximum temperature of 77C. That's almost as good as a more expensive TT ToughAir 510 at 75C. That's a fantastic result for a cooler that costs just $49 in an airflow-restricted case. Perhaps the only drawback was a bit of noise under load, but that's to be expected. It's something to be aware of if you're planning to use it with a 150W+ TDP CPU where its compact size will start to struggle vs coolers with a larger surface area.

It's important to remember we're dealing with a $49 cooler here. If you pair it with a mainstream CPU, you'll enjoy a capable and quiet running cooler that's easy to install and well built. We'd like to see a warranty a bit longer than three years, but as a replacement for a stock cooler, at $49 it's pretty hard to go wrong with the DeepCool AK400. Oh, and if you prefer white, keep an eye out for a white version of the AK400 in the coming months.

The AK400 is a low-cost single tower cooler that can dissipate up to 220W, making it a capable option for all but the hottest modern desktop CPUs.

The AK400 is a very affordable step up from underwhelming stock coolers, but it can get noisy if you ask too much of it.

Chris Szewczyk

★★★★☆

$499 | www.silicon-power.com

Silicon Power XS70 2TB

Silicon Power roars into the Australian high performance SSD market.

Silicon Power is a brand that doesn't have a lot of recognition in Australia, but when you look at its latest XS70 NVMe SSD and its performance specifications, it's not a brand you should write off. Armed with the latest Phison controller and high-performance NAND flash memory, a drive like the Silicon Power XS70 is capable of competing with the best SSDs on the market. Can the 2TB XS70 perform as good as it looks?

Like pretty much all retail M.2 drives released over the last few years, the XS70 is a 2280 (80mm length) M.2 drive. It makes use of Micron 176-Layer TLC NAND and a Phison PS5018-E18 controller, and has 2GB of DDR4 DRAM onboard. It's rated for 7,300/6,800MB/s sustained read and write speeds respectively. Add to that up to 1M/1M read and write IOPS and this is a drive that, on paper, can compete with the very best drives on the market.

Admittedly, we're talking about an SSD here, but the XS70 really does look nice. Even though it will remain out of sight in most instances, credit where credit is due. The XS70 is designed with PS5 compatibility in mind so the heatsink isn't as bulky as some others you might come across. During our testing we recorded a peak temperature of 63c. That's higher than some competitors, but much lower than equivalent heatsink-less designs like the Seagate FireCuda 530 at 71c.

The 2TB model we're testing comes with a 1400 TBW endurance rating to go with a five-year warranty. This matches most of the recent Phiso-equipped drives. The XS70 offers many of the usual features such as Trim support and S.M.A.R.T. monitoring. If hardware encryption is important to you, you'll need to look elsewhere.

As a Phison E18 drive with 176L NAND, we'd expect it to perform very closely to similar drives, such as the Seagate 530 and Kingston KC3000, and that's exactly what it does. Sequential speeds are all but tied. The KC3000 holds a very small (if insignificant) lead in random read performance, while the XS70 delivers excellent write performance. Since the launch of drives like the Seagate and Kingston, the space is becoming increasingly competitive, meaning performance isn't a clear differentiator. This makes value for money more important than ever.

At the time of writing, the Silicon Power XS70 2TB was priced at $499. That's not a bad price, but these days you can get a Samsung 980 Pro for less. Whether you go for the Silicon Power drive might come down to whether you want a heatsink or not. It's great for a PS5 but a no go if you plan to use it underneath a motherboard's integrated heatsink.

As SSDs increasingly shift towards being commodity-like products, we feel as though the SP drive needs to be a little cheaper to steal more market share. Compared to how the Seagate 530 and Kingston KC3000 were priced at launch, we're sure it will come down. And if that happens, it will become an even more formidable price/performance option. The excellent all-round performance on offer from the XS70 makes it a very competitive option and easily worth considering if it's price competitive at the time you look to make your purchase.

Specifications
Silicon Power XS70 2TB M.2 NVMe SSD; PCIe 4.0 x4; Phison PS5018-E18 controller; Micron 176L TLC NAND; 7300 MB/s sustained read, 6800 MB/s sustained write, 1M/1M read/write IOPS; 1400 TBW endurance; Five year warranty.

			Silicon Power XS70 2TB	MSI Spatium M480 Play 2TB	Kingston KC3000 2TB
Crystal Disk Mark	Sequential Read MB/s		7,349	7,359	7,386
	Sequential Write MB/s		6,881	6,870	6,891
Anvil Storage Utilities	4K Random Read MB/s	Queue Depth 1	81.95	81.61	83.07
		Queue Depth 4	324.98	323.50	328.70
	4K Random Write MB/s	Queue Depth 1	283.36	281.47	274.77
		Queue Depth 4	1,004.93	972.24	993.65
	4K Random Read IOPS	Queue Depth 1	20,878	20,816	21,266
		Queue Depth 4	83,196	82,841	84,146
	4K Random Read IOPS	Queue Depth 1	72,839	72,057	70,341
		Queue Depth 4	257,293	249,020	254,375
Internal File Copy	30GB of mixed file sizes				
FF XIV Stormbringers	Scene Loading Time			7.583	7.551

The Silicon Power XS70 is an excellent all-round drive, though the competition never stands still

Chris Szewczyk

★★★★☆

$499 | www.msi.com

MSI Spatium M480 Play 2TB

The Spatium M480 gets an upgrade.

Last year, MSI entered the high performance SSD market with a bang. Its Spatium M480 drive performed well against its competition, blending form and function, although we felt its launch price was a little high to earn an unequivocal recommendation. Fast forward to 2022 and the Spatium M480 has received an upgrade from Micron 97-layer NAND to the latest and greatest 176-layer chips. It's also built with PS5 compatibility in mind, making it a high performing and versatile option. But the competition hasn't been sitting idle either.

On the opposite page we've reviewed the Silicon Power XS70. The MSI is all but identical, as is the case with just about every high performance Phison-based drive. The M480 Play is a 2280 (80mm length) M.2 drive. It makes use of Micron 176-Layer TLC NAND and a Phison PS5018-E18 controller. It's got 2GB of DDR4 DRAM onboard. It's rated for 7,000/6,800 MB/s sustained read and write speeds but that seems to be a bit conservative. The 2TB model is rated for 650K/700K read and write IOPS.

The 2TB model we're testing comes with a 1400 TBW endurance rating and a five-year warranty. This fits in with most of the drives we've tested recently. You get Trim support and S.M.A.R.T. monitoring and in a welcome inclusion, AES256 hardware encryption support, which is something that many competitors lack.

Specifications
MSI Spatium M480 Play 2TB M.2 NVMe SSD; PCIe 4.0 x4; Phison PS5018-E18 controller; Micron 176L TLC NAND; 7000 MB/s sustained read, 6800 MB/s sustained write, 650K/700K read/write IOPS; 1400 TBW endurance; Five year warranty.

MSI has tweaked the design of the heatsink to ensure PS5 compatibility. It's subtle black design will blend in well with the company's motherboards. The first Spatium M480 delivered a very cool 56c operating temperature while the Play delivered a peak reading of 61C. That's a great result given the Play is the faster of the two.

When it comes to performance, we'd expect the M480 Play to perform much the same as other 176L Phison E18 equipped drives, and that turns out to be the case. Drives like the Spatium, Seagate FireCuda 530 and Kingston KC3000 are essentially all tied with one another. The Kingston just has the edge in read performance, while the MSI performs very well at write operations, much like the non-Play M480 does. In the end though, the differences are largely negligible, and that makes things like the design, software and most importantly, value for money the key purchase considerations.

The MSI Spatium M480 Play is priced at $499 for the 2TB model. At that price it's main worry is the cheaper Samsung 980 Pro, which is still a very good drive. It just happens to be the same price as the Silicon Power drive. But which should you go for given that performance is largely identical? We'd say the inclusion of AES256 encryption and Actiphy backup and restore software means the MSI gets the nod.

The MSI is a fast and cool running drive. It looks great and it's reasonably well priced at $499. We're happy to recommend it, but whether you go for it or not depends on what happens to be well-priced on the day you look to purchase it. You might want a PS5 drive, or a heatsink-less drive to install under a motherboard heatsink. SSDs are becoming commodity products. If you do choose the MSI, you won't be disappointed.

We're happy to recommend it, but whether you go for it or not depends on what happens to be well priced on the day you look to purchase it.

The MSI Spatium M480 Play brings flagship performance down to a new low price point.

Chris Szewczyk

★★★★½

$1,598 | samsung.com

Samsung Galaxy Tab S8 Ultra

Samsung's Android tablet goes Ultra big and Ultra thin.

The only Android tablet to really take on Apple's iPad Pro at the premium end of the market so far is the Samsung Galaxy Tab S7+, released back in August 2020. It turns out that wasn't premium enough for the Korean manufacturer, so now we have the Galaxy Tab S8 Ultra. The "U-word" has been rolled out for the first time to denote, as on the Galaxy phone line, that this is the very best in the range.

So what makes this tablet so Ultra, given that the S8+ also still exists? It's all about the screen – a ridiculous 14.6-inch OLED 120Hz display that's nearly as big as most 15-inch laptop panels. The Ultra model also boasts the thinnest body ever on a Samsung tablet at just 5.5mm, as well as dual front-facing cameras that work well for video calls, but are housed in an Apple-like notch that intrudes on the display.

The size of the Tab S8 Ultra is both its greatest strength and its biggest weakness. This is an incredible display – not quite as bright as the most recent iPad Pros, but bursting with colour and detail that make media consumption a joy. This is a tablet on which you can view magazines in landscape, such is the size and resolution of the display. It also makes the tablet a superb multi-tasker, as you can run three or four apps at the same time without compromise.

That said, holding the tablet in landscape is pretty much a necessity, as the height of the device in portrait makes it uncomfortable to hold for long periods of time. It's not heavy, nor is it thick or difficult to hold, but the weight distribution feels a little off. Some people will be able to overlook this, given the benefits of a laptop-sized display in tablet form, but the screen is a couple of inches too big. To paraphrase *Jurassic Park*'s Ian Malcolm, Samsung's scientists were so preoccupied with whether they could, they didn't stop to think if they should.

As a result, getting a stand is a must. Samsung's own Ultra Book Cover Keyboard costs a ridiculous $499 – at that extra price, most people would be better off buying a laptop. The official Protective Standing Cover represents much better value, and while it's not as slick a solution, you can then pair it with any Bluetooth keyboard or mouse.

Either of those setups will allow you to enable Samsung's DeX mode, which turns the tablet into a basic Android-powered laptop. It's best to think of DeX as an emergency or backup computer rather than a full-on laptop replacement. It allows you to browse the web and perform basic productivity tasks but is still some way short of Windows and Mac OS when it comes to app support, speed, and general ease of use. That said, DeX is a great bonus feature, which is sorely lacking from Apple's tablet offerings.

Another thing Samsung does better than Apple is the inclusion of the excellent S Pen stylus in the box. This is to be applauded, as it's both fluid and highly functional for sketching and note-taking. The charging on the rear of the device feels cumbersome and the pen is prone to detaching easily, but it can also be magnetically attached to the frame when not charging. The lack of a charger is a painful omission, however – we get that manufacturers are trying to help the environment, but charging the massive 11,200mAh battery without Samsung's 45W fast charger takes hours.

The biggest criticism of the Tab S7+, and indeed all Android tablets, remains though – Google's OS just isn't cut out for tablets in the same way as Apple iPadOS. For its part, Samsung is doing everything possible to change that. The new dual front-facing cameras include an ultrawide module for group calling, there's a feature to force apps to use landscape mode, and the video-editing app LumaFusion will soon be making its debut in the Samsung App Store.

The Samsung Galaxy Tab S8 Ultra is an enormously impressive tablet. While it makes a fantastic first impression with its gorgeous screen and thin body, we found longer-term concerns about general comfort when used as a tablet and the cost of its accessories. If you want the best Android tablet going though, there's no question this is it.

Specifications
CPU: Qualcomm Snapdragon 8 Gen 1 Octa-Core Processor; GPU: Adreno 730; Display: 14.6-inch, 2980 x 1848 pixel, Super AMOLED, 120Hz, 240ppi; Cameras: 13MP + 6MP (Rear), 12MP + 12MP (Front); Memory: 8GB RAM/128GB ROM (tested), 12GB RAM/256GB ROM, 16GB RAM/512GB ROM; Battery 11200mAh; Dimensions: 326.4 x 208.6 x 5.5mm; Weight: 728g.

Gorgeous screen, incredibly thin and great for multitasking., but no fast charger or headphone jack included.

Guy Cocker

★★★½☆

Designed for those seeking to get a gaming-grade mechanical keyboard at an affordable price, it offers many of the basics you'll find with any premium product.

$260 | www.corsair.com

Logitech G413 SE

A barebones basic board with the minimum possible set of features.

Logitech's G413 SE is a slim everyday keyboard with a handful of features that step it up into gaming territory. Designed for those seeking to get a gaming-grade mechanical keyboard at an affordable price, it offers many of the basics you'll find with any premium product, while lacking the customisation abilities of the top tiers of gaming keyboards today.

What you do get with the Logitech G413 is a decent features list for the price you pay – long Hua tactile mechanical switches, PBT keycaps, and a sleek design with white LED key backlighting. You get six key rollover with anti-ghosting allowing for multiple simultaneous inputs, but unfortunately the technical bells and whistles end there.

Typing on this keyboard is a pleasant experience. There is satisfaction to each keypress without the controversial clack normally found on mechanical boards. You'd be able to use a G413 in an office without frustrating all around you.

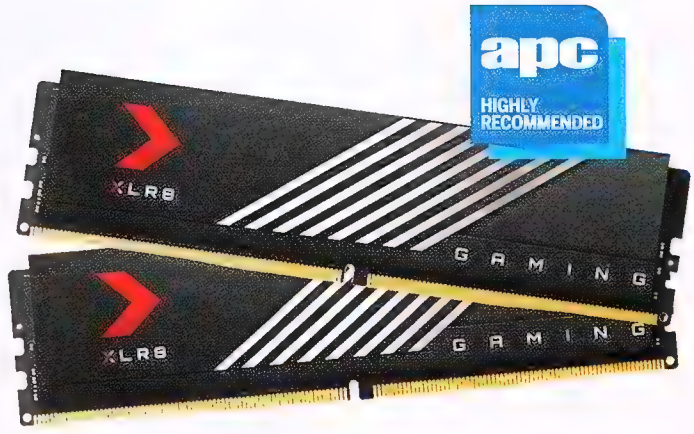
The most lacking feature on this keyboard is unfortunately the most exciting aspect being shipped with new boards today. There are no extra macro keys, specific media keys, and you cannot customise the keys. With Logitech's G-Hub already available for most of the company's gear, this feels like a mammoth oversight and would have vastly changed our perception of this board.

Overall there really isn't anything wrong with the Logitech G413 SE. Unfortunately, in the fiercely competitive world of keyboards today, there isn't anything that stands out as hugely right either.

If nice key feel is all that matters, this (barely) budget mechanical board only just delivers.

Rian Howlett

★★★½☆



$699 | www.pny.com

PNY XLR8 Gaming Mako DDR5-6000 2x16GB

A new challenger enters the ring with a high spec DDR5 kit.

PNY probably isn't the first name you'd think of when you make a shortlist of DDR5 memory kits, but there's no reason to not consider PNY given that memory is mostly differentiated by its design and IC selection.

The PNY XLR8 Mako kit we have for review comes with a DDR5-6000 rating, which definitely makes it a high-end kit. But while most SK-Hynix-equipped kits at this speed come with 40-40-40 timings, the PNY kit drops this to 38-38-38-77 at 1.3V. At this stage in the DDR5 lifecycle, there aren't many kits with timings that low apart from the still rare Samsung-based kits.

The kit lacks RGB so you'll need to look elsewhere if that's important to you. To some though, it's a plus! Add to that the low-profile design and this is a kit that's happy to run out of sight and out of mind while remaining compatible with almost all bulky CPU coolers on the market.

The PNY kit performed well in our benchmark results. It pulls ahead of a 5,200MHz kit, but not by a dramatic amount outside of the bandwidth sensitive 7-Zip file compression benchmark. It essentially ties with the Samsung-based G.Skill C36 kit.

At the time of writing, the PNY kit is priced at $699, which means it's priced at the same price point as G.Skill's Samsung-based Trident Z5 kits. The PNY kit omits RGB and has a lower profile and a subtler design. That alone may see it win some fans. If you've got a bulky CPU cooler, the PNY is one of few top spec kits that will fit right in.

		G.Skill Trident Z5 RGB DDR5-6000 2x16GB	PNY XLR8 Gaming Mako DDR5 6000 2x16GB
Handbrake 1.4.2	Video conversion 4K to 1080p FPS	81.4	81.3
Cinebench R23	Rendering - Multi thread Score	27,509	27,475
Ghost Recon: Breakpoint	1080p, Low, Avg FPS	237	237
Metro: Exodus Enhanced Edition	1080p, Ultra, DX12, Avg FPS	132.2	131.9

The PNY Mako DDR5-6000 kit is very fast, but it faces some tough competition at this price point.

Chris Szewczyk

★★★★☆

$1,217 | dell.com/en-au

Dell Ultrasharp U3223QE

Is this the sharpest tool in the box?

Maybe we need to get out more, but there was genuine excitement when the new Dell Ultrasharp U3223QE, a sober-suited 32-inch monitor designed primarily for productivity, landed at *APC*. The U3223QE has limited HDR support, no local dimming, runs at a mere 60Hz, doesn't have quantum dots or lots of tiny LED backlights. It isn't even curved.

So what's the big deal? Dell claims it is the first use of 'IPS Black' technology from LG, the first company to mass-produce IPS panels. IPS Black improves the contrast performance of IPS panels to fully 2,000:1. That's a big boost over the best existing IPS screens, which are good for 1,300:1 and have been stuck at that level for nearly a decade. Many current IPS screens only manage 1,000:1.

Of course, these figures refer to the static contrast achieved by the LCD panel itself. In other words, not contrast performance enabled by a backlight or local dimming. In many ways, improving static contrast is preferable to fancy backlight technology. It is less complex and costly to have good inherent contrast than mess around with complicated tech. Even now, few monitors have true full-array local dimming, and those that do cost megabucks.

So, a big improvement in static contrast will benefit monitors at a wide range of price points.

The Ultrasharp U3223QE has a strong productivity feature set. It's a 4K panel with slick slim-bezel styling, lots of desktop real estate, USB-C connectivity with 90W power delivery, monitor daisy-chaining and ethernet passthrough, plus a KVM switch. You also get excellent colour fidelity with 98 percent coverage of the demanding DCI-P3 digital cinema space. OK, this isn't a true pro-level panel for image and video editing. But that kind of colour coverage is certainly enough for most content creation workflows.

On paper, it's the step in contrast performance that sets this panel apart. In practice, it's far less impressive. In subjective terms, the U3223QE is little better in terms of contrast, vibrancy, and black levels than a monitor based on a good existing IPS panel. That isn't entirely surprising. VA panel tech is capable of 3,000 to 4,000:1 static contrast. And while that advantage is noticeable in comparison with an IPS monitor, it's not night-and-day.

It also doesn't help that the U3223QE's factory calibration is tilted towards green. This supposedly cutting-edge new IPS panel doesn't produce the cleanest or purest of white tones, either. There's a little compression evident in some test images. In fact, compared with another, less advanced, 32-inch 4K monitor, we prefer the older 1,300:1 panel. For the record, pixel response in the Dell's standard mode is adequate given the productivity rather than gaming remit. Achieving the claimed 5ms performance, however, requires enabling overdrive in the OSD menu, and with that comes some ugly overshoot and inverse ghosting.

All of which makes the Dell Ultrasharp U3223QE a little disappointing. Contrast performance is IPS's most obvious weakness. On this viewing, IPS Black doesn't do as much as we'd hope to address that. This remains a nice screen with all the usual benefits of a quality 4K monitor, including nice, crisp fonts and oodles of desktop elbow room. The comprehensive productivity and connectivity feature set is also excellent but none of those things are unique to the U3223QE. The bit that is, the IPS Black panel, doesn't do it for us.

Specifications

Panel size; 32-inchPanel type IPSResolution; 3,840 x 2,160 Brightness; 400cd/m2 Contrast; 2,000:1 Pixel response; 5ms Color coverage; 98% DCI-P3 Refresh rate; 60HzV esa; 100mm x 100mm Inputs; DisplayPort 1.4, HDMI 2.0, USB-C with 90W PD Other ; DisplayPort out, ethernet, HDR400

■

Epic productivity feature set plus the usual 4K thrills.

Jeremy Laird

★★★½☆

$899 | www.draytek.com.au

Draytek Vigor2865Lac

A performance focused multi-WAN router with dual SIM LTE and VDSL2 connectivity.

The DrayTek Vigor2865 router series has a large number of models, which includes an option with inbuilt 4G connectivity. The LTE equipped routers come in two otherwise identical versions, with and without Wi-Fi. The router also includes an ADSL2+ / VDSL modem, which supports 35B Supervectoring for higher connection speeds. The Vigor2865Lac (as tested) has five fixed gigabit LAN ports, one LAN/WAN connection, USB 2.0, and also adds in 802.11ac WiF-Fi, providing 400Mbps on 2.4GHz, and 86Mbps on the 5GHz band.

The 2865L series makes it easy for businesses to utilise a high speed internet connection away from the office, or provide multiple connection options for performance and redundancy. It also gives an option for easy to use SMS marketing via VigorSMS. The LTE modem uses dual antennas (with 1m cables, and magnetic bases), and is rated for cat 6 4G, with downloads of up to 300Mbps and uploads of 50Mbps. The 2865L supports the normal frequency bands needed for use in Australia across all providers. The LTE connection can be configured in a variety of ways, including acting as a backup, or kicking in when extra bandwidth is needed. You can run dual sim cards from different providers, to provide a failover to a completely different 4G network.

The Vigor2865 series includes hardware acceleration and has a robust firewall and security options. It provides a fairly impressive 800Mbps of NAT throughput (and up to 1.3Gbps with hardware acceleration in certain configurations) as well as 300 Mbps of IPSec VPN (and 130Mbps of SSL-VPN) throughput. You also get 60k NAT sessions, which is suitable for large networks with 50+ devices. The router also supports 32 VPN tunnels, and 16 SSL-VPN, plus 16 VLANs and eight LAN Subnets.

During testing, we found the Draytek web console dense but quite straightforward to use. There is also a large amount of support and knowledge base information available online. We tested the Wi-Fi version of the 2865L series, and found coverage and performance fairly good. The 2865Lac managed 657Mbps up close, and 302 Mbps at 10m range. Keep in mind that typically the Vigor2865 would be paired up with wireless access points, which will provide longer range and better throughput. During LTE testing, the 2865Lac was easily able to achieve higher speeds than other LTE devices on the same network.

The 2865 series is designed to be able to control a larger Draytek network – either directly via the Vigor2865 web interface, or a software management solution called VigorACS. This TR-069 compliant application provides a central interface to manage compatible Draytek hardware, such as access points, routers and switches, and is a must-have feature for larger businesses.

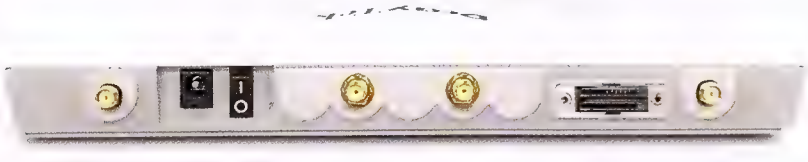
All in all, the 2865L series is a versatile yet powerful business router for those who need LTE connectivity, while the rest of the 2865 lineup does a great job catering for more specific needs.

Specifications
WAN Port: 1x LAN/WAN, 1x RJ-11; LAN Ports: 5x RJ-45 1GbE ; LTE: Cat 6 4G/3G Dual Sim; USB: 1x USB 2.0; Wi-Fi: 802.11ac; VPN Tunnels: 32; NAT Throughput: 800 Mbps; NAT Sessions: 60k.

While not the cheapest router, the Draytek Vigor2865Lac provides flexible yet high performance connectivity options for modern business needs.

Lindsay Handmer

★★★★☆



WINDOWS APPS | Free | wisecleaner.com

Wise Program Uninstaller

A basic software uninstaller that's entirely free.

Software uninstallation may seem trivial, but it's not. Leftover files from uninstalled software clog up your PC and slow it down. Hence, installing a capable software uninstaller is advisable.

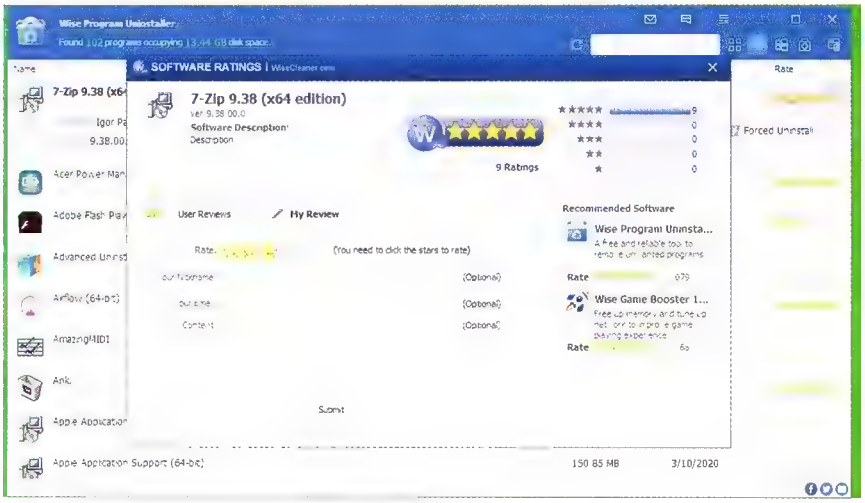
Wise Program Uninstaller was developed by WiseCleaner, a software company with offices in the U.S. and China. The company sells various system optimisation products, and the Wise Program Uninstaller is one of its best-known products.

Thanks to being entirely free, the Wise Program Uninstaller has won the hearts of many users worldwide and helped increase WiseCleaner's brand value. We're reviewing the software uninstaller based on specific criteria, including features, pricing, customer support, etc.

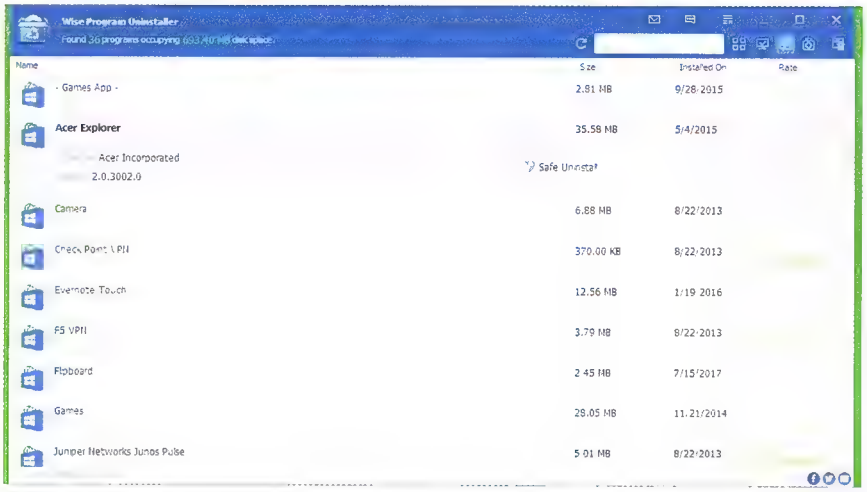
Wise Program Uninstaller is free. There's no payment involved. Just head to WiseCleaner's official website, and it's readily available to download. The fact that Wise Program Uninstaller is entirely free is a significant advantage over its competitors. It may seem surprising but think of the uninstaller as a goodwill marketing tool for WiseCleaner's other software products. Most rival software uninstallers have premium versions requiring payment, but WiseCleaner didn't go that route.

The software's core feature is to uninstall any software programs you select on your PC. Once you launch the app, it automatically generates a list of all the programs installed on your PC. You can choose anyone on this list to begin uninstalling. You can uninstall software programs individually or mark them as a group and uninstall them at once.

You have two choices when you select a program you want to uninstall; Safe Uninstall and Force Uninstall. Safe Uninstall uses the program's own uninstaller to remove it, whereas Forced carries out a deep scan to track any associated files with the app and remove them. You're advised first to select Safe Uninstall and use Forced only as a last resort. Forced eliminates any probability of recovering an uninstalled app.



Just head to WiseCleaner's official website, and it's readily available to download. The fact that Wise Program Uninstaller is entirely free is a significant advantage over its competitors.



It's not only software programs that the Wise Uninstaller lets you remove. You can also remove system components with it. Though, you have to be careful because uninstalling some system components can cause severe flaws in your PC.

There's also Custom Uninstall, which lets you eradicate a program that you can't remove routinely. This feature enables you to select programs directly from their root folder to uninstall them. The Wise Uninstaller has a rate column where you can see ratings that other app users have given each piece of software. It's an effective crowdsourcing tool.

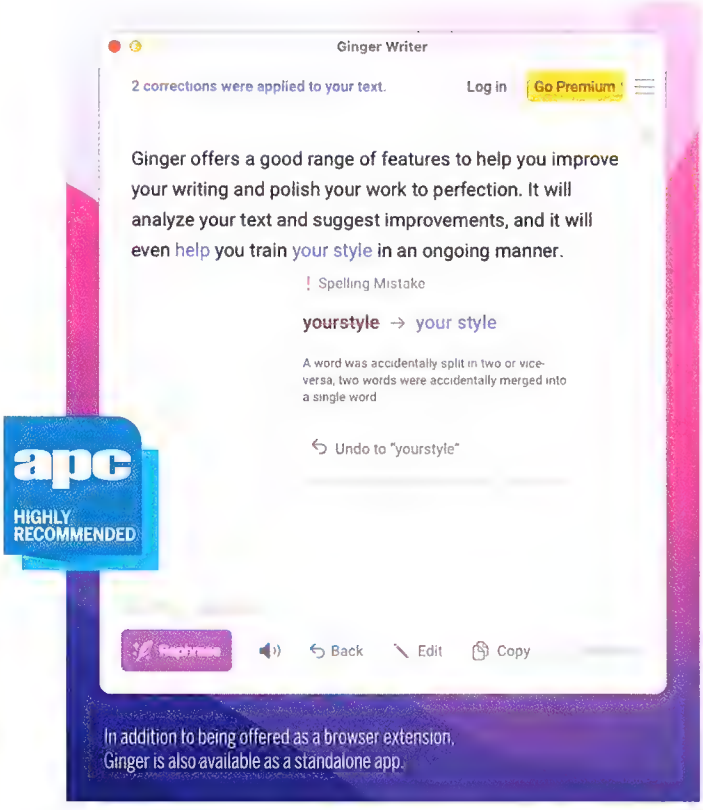
The user interface is a list of all installed programs on your PC and the ability to select them individually or in batches and uninstall them. There are no confusing menus or features hidden deep within specific menus. The software has just one core function: uninstall apps, so this interface is simple to understand and navigate.

Wise Program Uninstaller is a practical, helpful tool to remove unwanted applications from your PC. It's free and easy to use, making it one of the best of many software uninstallers.

It eradicates unwanted apps, leaving no leftover files behind.

Richard Sutherland

★★★½☆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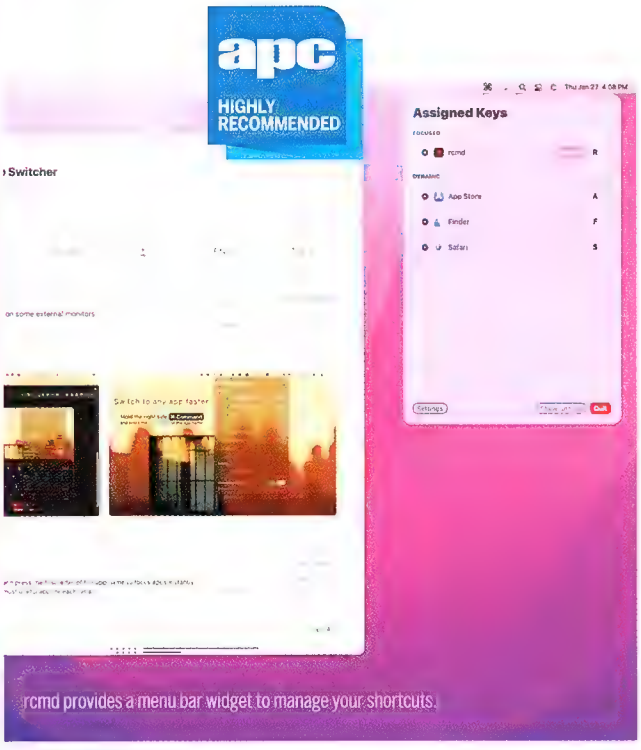
Spelling Mistake
yourstyle → your style
A word was accidentally split in two or vice-versa, two words were accidentally merged into a single word
Undo to "yourstyle"
Back
Edit
Copy
apc
HIGHLY RECOMMENDED
In addition to being offered as a browser extension, Ginger is also available as a standalone app.



MAC STORE & OTHER MAC APPS
Free (Premium $29.99) | gingersoftware.com

Ginger Writer

AI-power to improve your writing.

Ginger offers a good range of features to help improve your writing and polish your work. It analyses text and suggests improvements, and it even helps you train your style. It offers everything in a package that doesn't take long to get used to.

Ginger helps you identify weaknesses in writing style and shows you opportunities for improvement. You can use it to avoid repetitive wording, awkward phrasing, common grammatical and structural problems, and various other issues. Many of the tools are driven by AI, making them reliable and comprehensive. You can also use a rephrasing tool to help bring some variety into your work. However, reworded phrases need checking as they can sometimes sound awkward.

Ginger has a simple interface that's easy to use, and the application rests nicely in a small window on the desktop. It can also integrate with Microsoft Word and popular web browsers through extensions, or there's a dedicated app for Mac. Ginger has a free version, though it comes with various limitations – you can only make limited corrections and rephrases. With the premium version you can correct multiple mistakes with a click, and you can get a translator. The Premium plans can be purchased on a monthly and annual basis.

A great tool for those who are serious about their writing.
Stefan Ionescu
★★★★☆

MAC STORE & OTHER MAC APPS
$5.99 | lowtechguys.com

rcmd

Quick, customisable app switching.

Tired of Apple's default App Switcher shortcuts? Try rcmd. This lets you change apps by pressing the right-command button and the first letter of the app you want to switch to. For example, right-command+M will switch to Mail.

It's a clever idea that works best when you have many apps open at once. Instead of using command+right arrow to cycle endlessly through apps, a quick rcmd shortcut does the job. If you have multiple apps with the same first letter, press that letter multiple times to cycle through them (pressing right-command+S will cycle Spotify, Shortcuts, and System Preferences, for instance). Alternatively, you can hide an app using its shortcut. You can even change the trigger key (right-command) if you like.

The app lets you assign custom shortcuts, which is helpful if you use two apps with the same first letter. Open your chosen app, then press right-command and right-option, then a letter, to assign it something new (for example, right-command-right-option-T for FaceTime). You can also do this from the menu bar icon.

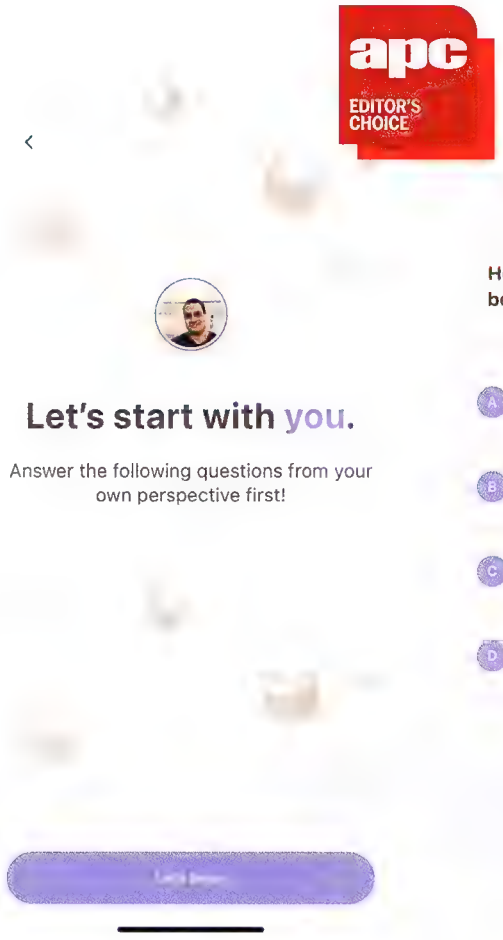
In some cases, command-right arrow is faster and easier to use one-handed. But rcmd gives you an extra dose of optional firepower with built-in customisation to boot. For $5.99, we think it's a worthy addition to your Mac.

A handy, customisable utility that speeds up app switching on your Mac.
Alex Blake
★★★★☆

Free with optional subscription | Android

Paired

Pair with your partner.


apc
EDITOR'S CHOICE
Let's start with you.
Answer the following questions from your own perspective first!
How would you describe your bedroom?
A Perfectly tidy
B Cozy and lived-in
C Argh, need to put stuff away
D Who needs floor space, anyway?

Paired is part of a wave of relationship apps that started a very long time ago with Avocado, a "private" messenger that aimed to offer a more tailored and romantic experience by locking the app functions to two people. It also featured quizzes and prompts to send messages and love notes throughout the day.

Paired takes this concept and bulks it up somewhat, creating a host of games, quizzes and other content that aims to actively improve your relationship by creating conversations around topics that aren't usually discussed daily.

I've been trialling it with my wife for a week and I've found the conversations and answer comparisons both fun and interesting. The application team has hired professional therapists and councillors to create content, and each quiz has a scientific edge to it, and includes a drop down that explains why it is relevant or important to answer.

Paired doesn't overextend its welcome, usually only prompting once a day with a request, and it seems to be updated regularly. It's likely that there are algorithms that analyse answers and use that information to suggest new ones, as well as "global" challenges against other couples to have more conversations.

Controversially, Paired is likely the most expensive of these apps to use – its cheapest plan is $8.13 a month, billed annually at $99. Monthly, it jumps up to $20. Paired claims this cost is to ensure its content is rooted in social science, but I would dispute the longevity of this app over a year.

It also, interestingly, claims it is cheaper than marriage counselling, which is true, but I would be loath to compare the two, other than both encourage communication on tougher issues. It's certainly a unique tactic in order to attract sales however, but I would say the app is probably a little pricey for what if offers. Subscriptions on specific apps are a bit of a financial landmine.

On that point, it works well, and my wife and I enjoyed it enough to carry through to purchase. Recommended.

★★★★½

James Pinnell

Free with optional subscription | iOS/Android

TASTE.COM.AU

Local recipes.

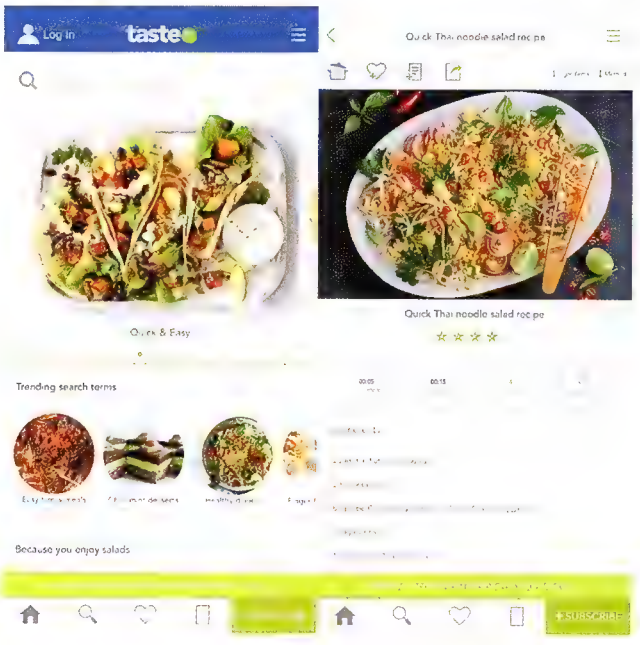
Taste is arguably the most popular recipe website on the Australian internet, fuelled largely by its sheer longevity – it has been on the active web for the best part of 15 years. It also made deals with larger supermarkets to promote its recipes and link to those sites for groceries.

Until recently, the site was free, and the app was essentially a rap for the website, which made it quite poor to use. It's since been updated and now includes a weak algorithm of sorts that attempts to figure out what sort of recipes you'd want to make. It doesn't work well at all.

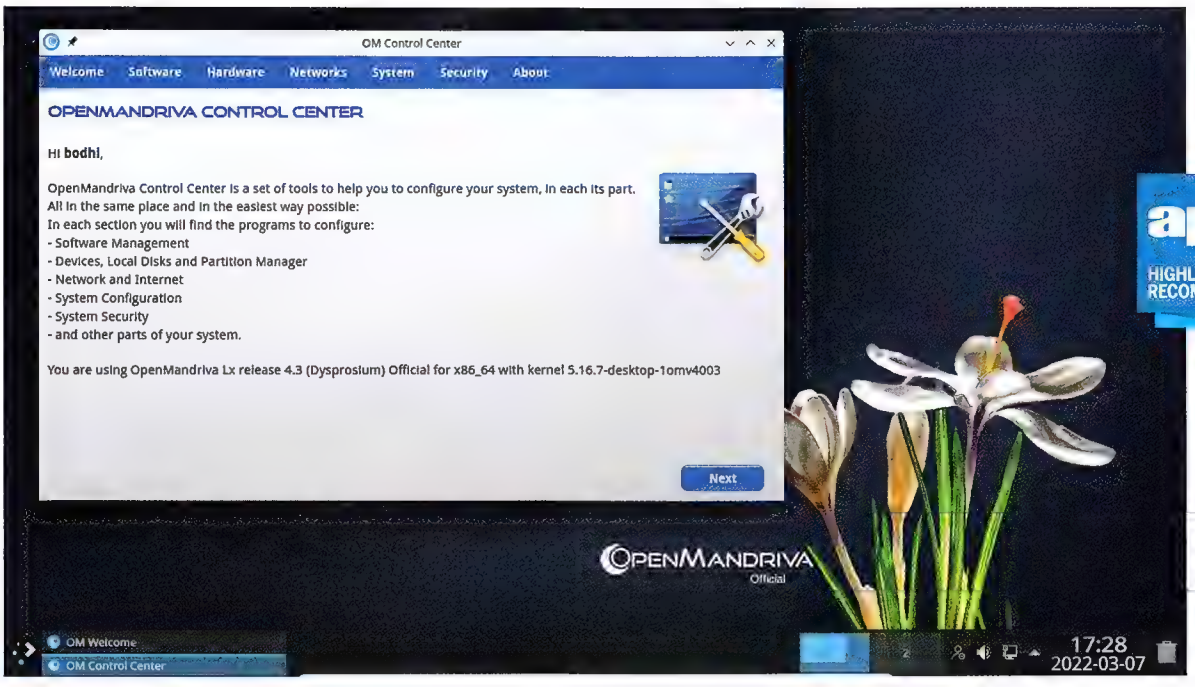
Additionally, there is now a subscription fee if you want to view more than 10 recipes. Thankfully, it's only $1 a month, which is the minimum that Apple/Google require, so it's very reasonable if you use Taste often. But in all honesty, it would have been nicer if it was just a one off charge.

★★★☆☆

James Pinnell



Taste is arguably the most popular recipe website on the Australian internet.



If you want to test OpenMandriva's Clang-compiled kernel, you can do so using the convenient option in the welcome application.

LINUX APPS | Various Licences available | www.openmandriva.org

OpenMandriva Lx 4.3

In what seems to have become a trend, just when he gives up hope, a project pleasantly surprises Mayank Sharma with a new release.

Released after almost a year of development, the OpenMandriva developers didn't plan to have a 4.3 release, but decided to create it to push the changes made behind the scenes without keeping users waiting a few more months for version 5.0.

OpenMandriva Lx 4.3 is available as an installable live media. In addition to the generic 64-bit release, there's also a version built specifically for the current generation of AMD processors including Ryzen, ThreadRipper and Epyc. The developers claim this version outperforms the generic 64-bit release by taking advantage of new features in the AMD camp.

This is also the first OpenMandriva release that's available for 64-bit ARM devices. Installable images for popular ones such as the Pinebook Pro, as well as for single-board computers including the Raspberry Pi, are being tested and will be released shortly. The developers also claim that the aarch64 port enables them to target smartphones as well, and there's a beta-quality image for the PinePhone available.

The majority of its interesting changes are behind the scenes. The release continues OpenMandriva's tradition of using the LLVM compiler, as opposed to GCC that's used by most other distros. The developers claim the compiler's link time optimisation makes the desktop and the programs a lot more responsive. And thanks to the new LLVM Clang 9.0 release, it's now possible to use LLVM Clang to compile the mainline Linux kernel, and the release offers one for users to test.

The release has some interesting changes to the frontend, too. The distro still defaults to using the KDE desktop environment, but PipeWire has now taken over as the default sound server replacing PulseAudio, and the distro's custom utilities get a fresh lick of paint.

The first of these that users will run into is the welcome utility, which introduces the distro and helps users tweak key aspects of their computer. The utility also has a list of tools, both open source and proprietary, to help users flesh their installations.

The welcome app points to another OpenMandriva speciality, the desktop presets utility that leverages KDE's famed malleability to rearrange the desktop furniture and make it resemble the interface of other popular operating systems like Windows, and macOS.

Outside of the welcome screen, you can pull in additional programs using either KDE's Discover tool store or the Dnfdragora frontend to the command-line dnf package manager.

The distro defaults to using the stable repository it calls Rock, although there's a rolling branch also for users who want to stay on the bleeding edge. You can switch between the repositories using the custom software repository selector tool. While you can easily switch between the two update channels, the developers ask never to mix the repositories from different release versions or update channels.

Of course, the distro's marque custom tool is the OpenMandriva Control Centre, which is also accessible from the welcome tool. It has a neatly arranged menu that houses a plethora of tools and utilities to help users configure and personalise their installations.

If you're a KDE fan, OpenMandriva is one of the classiest renditions of the desktop. Not only does it ship the latest edition of the desktop, its custom tools make tweaking, tailoring and administering the installation a mouse-driven activity. The distro focuses on the desktop user, and is optimised, from the kernel upwards, to deliver a streamlined user experience.

A well-put together desktop distro that works as advertised and even offers specialised builds for users with AMD chips.

★★★★☆

FIRECUDA
530 Series
PCIe Gen4 SSD
SEAGATE

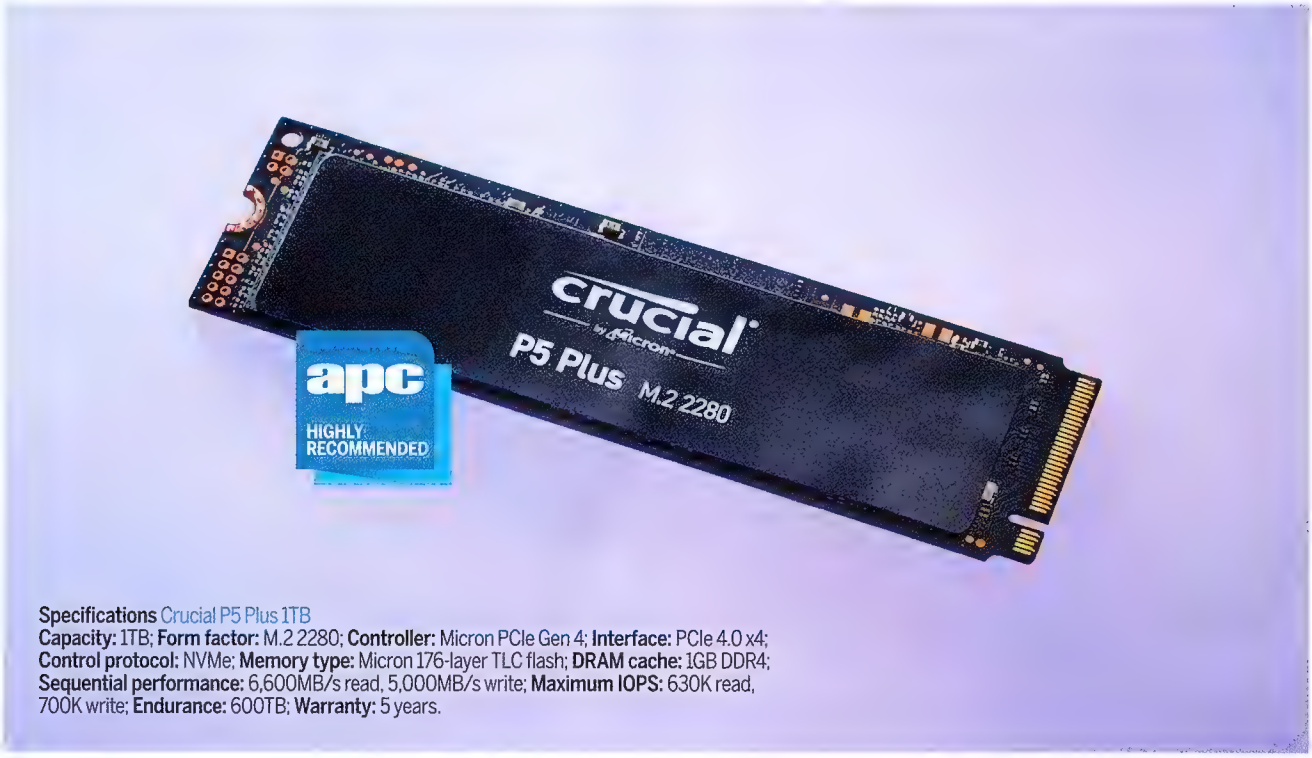
SO SOLID

[illegible] quick PCIe Gen 4 drives are now almost [illegible] Laird chooses from six of the speediest NAND SSDs.

It took its merry time. But with the latest 12th Gen Alder Lake CPU family, Intel can finally support PCIe Express Gen 4 on the desktop. Better 18 months later than AMD and its PCIe 4.0-capable Ryzen 3000 CPUs than never, right?

You now have free reign to build a PC based on a platform from either of the core hardware vendors without worrying about interconnect spec. As for why PCIe 4.0 matters, as ever, it comes down to speed. If you want the fastest connection speed for peripherals, you need PCIe Gen 4. And if there's a single component that benefits most from more PCIe bandwidth, it's storage. Gen 4 doubles theoretical bandwidth over Gen 3 to fully 8GB/s in both directions. Thanks to AMD's early move in the Gen 4 space, there are already a wealth of PCI Express Gen 4 drives to choose from and several get remarkably close to the full capability of the interconnect.

What's more, SSDs have avoided the debilitating price rises suffered by some PC components over the past year or two. Now, you not only get more speed but also more storage for less money. By CPU and GPU standards, a multi-TB SSD is positively affordable. None of which means, however, that all Gen 4 drives are equal. So, it's time to find out how six of the very best perform.



Specifications Crucial P5 Plus 1TB
Capacity: 1TB; **Form factor:** M.2 2280; **Controller:** Micron PCIe Gen 4; **Interface:** PCIe 4.0 x4; **Control protocol:** NVMe; **Memory type:** Micron 176-layer TLC flash; **DRAM cache:** 1GB DDR4; **Sequential performance:** 6,600MB/s read, 5,000MB/s write; **Maximum IOPS:** 630K read, 700K write; **Endurance:** 600TB; **Warranty:** 5 years.

$229 | www.crucial.com

Crucial P5 Plus 1TB

At just a few dollars more than you have to pay for the Crucial P5 Plus 1TB with PCIe Gen 4 capability over the older Crucial P5 Gen 3 drive, the plain old P5, should we need to remind you, returns barely more than half the performance by several measures. Even if you don't have a Gen 4 capable rig right now, it surely makes sense to go with the Gen 4 drive and future-proof your storage for any possible CPU and motherboard upgrade.

With that in mind, it's not a huge surprise to find the Crucial P5 Plus is the cheapest drive on test. Less than $230 for 1TB's worth of Gen 4 goodness in an M.2 package? Sign us up! It's not as if this drive cuts any obvious corners in terms of specifications either.

Partly, that's thanks to the fact that Crucial's parent company Micron is one of the world's biggest producers of the NAND flash memory that goes into SSDs. So, it gets access to the latest chips for less cash than the competition.

In this case, we're talking Micron's latest TLC or triple-level-cell flash memory and so none of that clunky, cheap QLC gunk. Micron reckons the new 176-layer NAND chips are a major upgrade over the more familiar 96-layer NAND memory, with lower latency, more throughput, and better endurance.

Of course, it's not just flash memory Crucial does in-house. It has its own SSD controller chips, too, now updated for PCIe 4.0. Crucial hasn't been forthcoming regarding the specs of the new controller, but we know the old Gen 3 model was a six-core chip, so that's likely to be the case again. It certainly has eight memory channels and on this 1TB M.2 drive hooks up to 1GB of DDR4 cache.

Hardware-based AES 256-bit encryption and the obligatory SLC cache mode, which increases performance by allowing a portion of the drive to be dynamically allocated to run in faster single-level-cell mode, are also in the mix. As for write endurance, this 1TB version is rated at 600TB and also covered by a healthy five-year warranty, which should be plenty for all but the most demanding users. In short, there are no obvious omissions, no signs of cutting corners to save costs.

That said, the claimed 6,600MB/s peak read and 5,000MB/s write sequential performance is clearly a little off the pace of the quickest PCIe Gen 4 drives. The same goes for random access performance, which is rated at 630,000 read IOPS and 700,000 write IOPS. Several drives on test this issue are good for one million IOPS, by the official numbers at least. So, something has gone slightly amiss to hit the lower price point.

That carries over to our benchmarks. The P5 Plus proves good for the claimed sequential throughput, though performance in short queue depth 4K random workloads of 69MB/s and 174MB/s for reads and writes is a fair way off the fastest drives. If synthetic benchmarks only tell you so much, the P5 does well in the more real-world PC Mark Storage index, notching up an impressive 3,140 points.

On the subject of sustained performance, throughput drops off consistently after around 300GB of writes, which likely reflects the maximum possible size of the dynamically allocated SLC cache. We also found a brief performance blip after 200GB, possibly due to thermal throttling, the latter arguably confirmed by the fairly toasty peak temp of 69°C under load.

If that's not exactly reassuring, the warranty and Crucial's broader reputation for quality and customer support should do the trick. Technically, then, this isn't the most impressive drive. But it's likely all the SSD you need for a pretty great price.

Hardly a slouch, five-year warranty, 4K performance unspectacular and runs pretty warm.
★★★★☆

Specifications Kingston Fury Renegade 2TB
Capacity: 2TB; **Form factor:** M.2 2280; **Controller:** Phison PS5018-E18; **Interface:** PCIe 4.0 x4; **Control protocol:** NVMe; **Memory type:** Micron 176-layer TLC flash; **DRAM cache:** 2GB DDR4; **Sequential performance:** 7,300MB/s read, 7,000MB/s write; **Maximum IOPS:** One million; **Endurance:** 2,000TB; Warranty: 5 years.

$629 | www.kingston.com

Kingston Fury Renegade 2TB

As a measure of just how successful the Phison E18 PCIe Gen 4 controller chip for SSDs has become, consider that the Kingston Fury Renegade 2TB isn't even alone among Kingston's M.2 drives in using it. The Kingston KC3000 also packs the E18 controller.

Among the SSDs tested this issue, you can also add the PNY XLR8 CS3140 and Seagate Firecuda 530 to the list of E18 groupies. All of which begs the question why? What is it that makes the E18 so popular? The Phison PS5018-E18, to use its full nomenclature, is an eight-channel controller produced on TSMC's 12nm process. It comes configured with five CPU cores in total, three of which use ARM's Cortex R5 IP with the remaining two designed by Phison itself.

All told, Phison reckons the E18 is good for 7.4GB/s sequential read performance and 7GB/s writes, plus the minor matter of one million IOPS. Those sequential numbers aren't far off the peak 8GB/s theoretical throughput of a quad-lane PCIe 4.0 M.2 interface, which this and every other SSD this month use. So, it's a pretty serious bit of kit.

As it happens, Kingston's specs for this implementation of the E18 mostly align with Phison's. Peak reads for this 2TB version of the Fury Renegade are rated at 7,300MB/s, with the full 7,000MB/s for writes and once again one million claimed IOPS. Controller aside, Kingston says the Fury Renegade uses TLC NAND without going into specifics.

However, we're pretty confident it uses Micron's latest 176-layer chips. And that's a good thing. We say that without peeling off the thin aluminum heat spreader. It would be a pity to do that, what with its fancy layer of graphene for optimised thermal conductivity.

Intriguingly, the Fury Renegade drive actually has slightly less usable space at any given capacity compared with its KC3000 Kingston sibling. That enables greater redundancy provision for the Fury Renegade and in turn superior write endurance. The 2TB KC3000 is rated at 1,600TB of writes, but the 2TB Fury Renegade achieves a fairly epic 2,000TB. Of course, hardly anyone is going to run into the 1,600TB wall in the real world. But endurance to spare is always reassuring, especially for the long haul.

Speaking of provisioning, this drive also had a healthy allocation of high-performance SLC cache. Peak sustained performance is maintained for fully 700GB before the SLC cache runs out and the underlying performance of the TLC chips is exposed. That's a lot of data to be getting on with and means that this drive will rarely fall back on TLC as opposed to SLC performance.

Inevitably, there's a fair amount of overlap among Phison-powered drives when it comes to performance. You'd struggle to squeeze a cigarette paper between the Fury and the Seagate Firecuda 530 when it comes to peak sequential performance, even if it's actually the XPG Gammix S70 that knocks out the highest read speeds of all.

As for 4K random access performance, it's a similar story here, too. The Fury is up there with the best. It also cranked out a particularly good result in PCMark 10's full drive test, topping the tables with 3,177 points.

Just as impressive, this drive runs nice and cool despite lacking a fat heatsink. Our peak measured temperature of 44°C makes it unlikely you'll ever run into problems with thermal throttling. It also bodes well for longevity in terms of reduced thermal stress on the drive's PCB. All of which means this is a good SSD with just one problem. Like the other Phison-powered 2TB drive, the Seagate Firecuda 530, it's hellishly pricey.

Awesome all-round performance and epic endurance. Very expensive; 4K throughput is nothing special.
★★★★☆

Specifications PNY XLR8 CS3140 1TB
Capacity: 1TB; **Form factor:** M.2 2280; **Controller:** Phison PS5018-E18; **Interface:** PCIe 4.0 x4; **Control protocol:** NVMe; **Memory type:** Micron 96-layer TLC flash; **DRAM cache:** 1GB DDR4; **Sequential performance:** 7,500MB/s read, 5,650MB/s write; **Maximum IOPS:** One million (Phison E18); **Endurance:** 2M hours MTBF; Warranty: 5 years.

$303 | www.pny.com

PNY XLR8 CS3140 1TB

Give it up for our second Phison E18-based drive, the PNY XLR8 CS3140. Handily, we have the PNY in 1TB format, allowing a look at both 1TB and 2TB drives with the controller du jour for drive integrators who don't have the desire or means to do one in-house.

PNY is pretty punchy about the performance of this drive, claiming an eye-popping 7,500MB/s per second for sequential read performance, which is as fast as we can recall for a single consumer NAND-based SSD. For what it's worth, that figure is also higher than the supposed maximum speed Phison claims for the E18 controller used by the CS3140. Make of that what you will.

Inevitably, writes are a little tardier at 5,650MB/s, which is actually in excess of 1GB/s slower than the 2TB variant of the CS3140. PNY doesn't exactly share when it comes to details like maximum IOPS performance or the identity of the NAND chips it uses. The former is largely a known quantity thanks to the Phison controller and with a little digging around, the latter is revealed to be Micron's 96-layer TLC rather than its latest 176-layer chips. Perhaps that aspect can change, hence PNY prefers not to tie the spec sheet to a particular NAND spec.

If that's all fine, it is annoying that PNY doesn't quote write endurance, opting to provide an MTBF or mean time before failure rating of two million hours. In our view, that's fairly meaningless. You'd expect an SSD sitting around doing not much to last a long time, while a drive handling loads of write and erase traffic might tank relatively quickly.

Still, with the Phison controller, Micron NAND chips, a five-year warranty, and nice cool running (more on that later), it's not like we're actually concerned about longevity. We'd just prefer more clarity.

All that aside, this 1TB model of the PNY XLR8 CS3140 gets 1GB of DDR4 cache memory, plus the minor matter of a fat heatsink. Ostensibly, that bodes well for thermals. The complication is that many motherboards integrate their own heat spreaders, making the chunk of metal on the CS3140 arguably redundant.

Before anyone suggests it, however, this particular heatsink is not a sop for Sony PS5 owners – as is the case with so many SSDs of late, including the newly-tweaked Samsung 980 Pro Heatsink. As it happens, PNY's cooler is twice as thick as the maximum specifications for that console, so it's a non-starter.

As motherboard-based SSD cooling solutions vary, it's not at all straightforward to determine whether PNY's heatsink solution will be better or worse by comparison. What we can say, however, is that not only does the PNY CS3140 run cooler than the other Phison-based drives, it's the coolest customer of all six SSDs here.

Anyway, in terms of tested performance peak throughput is a little less than we'd hoped for at a little over 7GB/s for reads and around 5.2GB/s for writes. The drive's 4K sequential reads come in at 72MB/s, which again is slightly off the pace. Both the Samsung and the other Phison drives crack the 80MB/s barrier.

Meanwhile, if you are wondering how much of the main NAND memory PNY allows for high-performance SLC cache, our testing indicates the dynamic allocation can go as high as 300GB, which should be enough for most needs.

For the record, you can have the PNY XLR8 CS3140 without the beefy heatsink, but it's barely any cheaper than this variant. So, it doesn't fix this drive's main problem, which is the price tag. It's a good SSD – just that you can have something else just as good for quite a bit less cash.

Great performance and runs super cool, but like all Phison drives it's awfully expensive.
★★★½☆

Specifications Seagate FireCuda 530 2TB
Capacity: 2TB; **Form factor:** M.2 2280; **Controller:** Phison PS5018-E18; **Interface:** PCIe 4.0 x4; **Control protocol:** NVMe; **Memory type:** Micron 176-layer TLC flash; **DRAM cache:** 2GB DDR4; **Sequential performance:** 7,300MB/s read, 6,900MB/s write; **Maximum IOPS:** One million; **Endurance:** 2,550TB; **Warranty:** 5 years.

$595 | www.seagate.com

Seagate FireCuda 530 2TB

Funny old thing, the storage market. You might have expected the traditional magnetic drive outfits to pile heavily into solid-state storage. After all, the writing isn't just on the wall for those magnetic platters, it's burned right into their spinning surfaces. It's not that the future is solid-state – the shift has already happened.

Until now, the exception has been WD, with the SN850 Black being a particular success and one of the best of the current generation of PCIe Gen 4 drives (read about the SN850 at the end of the group test). But Seagate? While it has been active in the SSD market, it hasn't exactly made headlines.

That deserves to change with the new Seagate FireCuda 530 2TB. It's a very good drive. Surprisingly, given Seagate's status as a long-time big hitter in the storage market, this M.2 drive uses, yes you guessed it, the Phison E18 controller. Just like the PNY XLR8 CS3140 and Kingston Fury Renegade, not to mention numerous other drives on the market. Pretty much every Phison-based drive we've tested flies. So, that's got to be a good thing.

As for NAND flash memory specification, Seagate has likewise gone for Micron's latest 176-layer TLC NAND memory. Micron reckons it's quicker, denser, and more durable than its existing 96-layer memory chips. In our experience, the 176-layer stuff is up there with the very best. This is also the 2TB configuration of the FireCuda 530, so it gets 2GB of DDR4 cache. For headline performance, Seagate claims 7,300MB/s for peak reads and 6,900MB/s for writes. So far, then, this all feels like a fairly familiar, if impressive, recipe.

If there is an exception to the identikit spec list, it involves write endurance. Seagate rates the 2TB model of the FireCuda 530 as good for 2,550TB of writes, which is moderately staggering. We suspect Seagate has used its undoubted experience and engineering nous to tweak the Phison E18's firmware to allow for a bit more endurance than the direct competition.

Whatever, it's hardly a shock to find this drive knocks out numbers not dissimilar to other Phison-based Gen 4 M.2 SSDs. Indeed, for sequential reads and writes, it's essentially indistinguishable from the Kingston Fury Renegade 2TB. Which is to say it's fast, seriously fast. Only the XPG Gammix S70 2TB is quicker in terms of reads, but not by all that much.

Also in line with other Phison drives is the 4K random access performance, with 83MB/s reads and 251MB/s writes. All the while, this thing keeps impressively cool, maxing out at 41°C. That's especially good considering this drive doesn't have a heat sink. If you're wondering about sustained performance and the size of the FireCuda 530's SLC cache, we found full performance is maintained for at least 700GB of writes, which has to be enough for just about any realistic workload.

Add it all up and you have a speedy, cool-running drive. There isn't much that's tangibly quicker out there on the market, something you can of course say about most Phison E18-based M.2 Gen 4 SSDs. The other thing you can say about this SSD, along with its Phison pals, is that it's pricey. It's a legitimate question to ask if you can feel the difference compared to cheaper and ultimately only slightly slower drives.

That said, the FireCuda 530 arguably has a trump card that places it apart from its direct competitors. As hinted by the exceptional endurance rating, if our lives depended on one of the Phison drives here outlasting the others, we'd choose this Seagate drive and the reputation and experience that comes with one of the best-known brands in storage.

Seriously speedy all-round performance; andstaggering endurance, though not cheap.
★★★★☆

Specifications Samsung 980 Pro Heatsink 1TB
Capacity: 1TB; **Form factor:** M.2 2280; **Controller:** Samsung Elpis; **Interface:** PCIe 4.0 x4; **Control protocol:** NVMe; **Memory type:** Samsung 128-layer TLC flash; **DRAM cache:** 1GB DDR4; **Sequential performance:** 7,000MB/s read, 5,000MB/s write; **Maximum IOPS:** One million; **Endurance:** 600TB; **Warranty :** 5 years.

$269 | www.samsung.com

Samsung 980 Pro Heatsink 1TB

For an awfully long time, Samsung was the gold standard when it came to SSDs. Year after year, when Samsung released its latest premium SSD, it went straight to the top of the performance tables. It was a textbook example of how the sheer engineering might of one of the world's biggest tech companies made for a competitive advantage.

Funnily enough, that was still pretty much the case when Samsung wheeled out the standard 980 Pro. And this 980 Pro Heatsink 1TB is largely the same drive. So, that makes it a nailed-on certainty for the win, right? Actually, no. The problem is that the 980 Pro was launched way back in the spring of 2020. The market has since moved on and the 980 Pro has been marginally overtaken.

The big news with this iteration of the 980 Pro is the heatsink. Samsung says the heatsink has been optimized courtesy of "data center technology" to dissipate heat efficiently from the controller chip, which is, of course, Samsung's own design.

If that sounds a bit like marketing fluff, then what we can say for certain is that the heatsink takes this M.2 drive's thickness to 8.5mm. Not at all coincidentally, that makes it fully compatible with the Sony PS5 game console, which is really why this new variant exists. As for how much sense it makes on the PC, we'll come to momentarily.

Beyond that, there's little else new to report, the tech specs are the same as at launch 18 months ago. That doesn't mean this SSD is totally outclassed, however. Far from it. You get 1GB of DDR4 cache, a five-year warranty, and, of course, Samsung's own high-quality TLC NAND memory. More to the point, this is still a cutting-edge PCIe Gen 4 drive with pretty stellar read and write speeds of 7GB/s and 5GB/s respectively. Samsung also says it will do no fewer than one million IOPS, which is as good as any NAND-based SSD we know of.

Not as impressive is the maximum 144GB of space the drive can allocate to operate in speedy SLC mode. Notably, that's less than the two other 1TB drives here, which both allocate up to 300GB. How much that will actually matter in practice is debatable. Arguably, most users will find that 144GB is plenty for sustained performance. But it can't be totally ignored.

In any case, our testing confirms that sustained throughput does indeed drop after roughly 140GB of sustained writes. As for operating temperatures, we registered a peak of 53°C sustained load, which is just fine for both sustained performance and overall longevity.

By other performance metrics, this slight tweak to the existing Samsung 980 Pro is unsurprisingly a dead ringer for the original. So, it's a very quick SSD, but not quite as speedy as most of the newer PCIe 4.0 M.2 drives in this group. 6.7GB/s reads and 4.9GB/s writes are nice numbers in isolation. But the fact is they are bested, even by the Crucial P5 Plus, which is a cheaper drive positioned in a more mainstream part of the market.

Of course, some would argue that such measures of peak sequential performance are somewhat academic in the real world. Once you've got several GB/s of throughput, the details don't matter that much.

Even if that is true, the 980 Pro is still behind when you factor in 4K random access. 4K write performance of 200MB/s is particularly weak compared to all but the Crucial P5 Plus.

All of that would actually be fine were it not for one small snag. The 980 Pro Heartsink is priced like it's right at the top of the performance tree. But it isn't, not quite. So, for that reason alone, it's hard to recommend for the PC.

Still has strong all-round performance and the Samsung brand is reassuring.
★★★½☆

Specifications XPG Gammix S70 2TB
Capacity: 2TB; **Form factor:** M.2 2280; **Controller:** InnoGrit IG5236; **Interface:** PCIe 4.0 x4; **Control protocol:** NVMe; **Memory type:** Micron 96-layer TLC flash; **DRAM cache:** 2GB DDR4; **Sequential performance:** 7,400MB/s read, 6,800MB/s write; **Maximum IOPS:** 650K read, 740K write; **Endurance:** 1,480TB; Warranty: 5 years.

$459 | www.xpg.com

XPG Gammix S70 2TB

Just when you were beginning to think that Phison had a complete stranglehold on the third-party SSD controller market, here comes the XPG Gammix S70 to blow that notion away. Lift this M.2 drive's beefy alloy lid and you'll find none other than an InnoGrit IG5236 chip, which is somewhat intriguing.

So, what can we tell you about the InnoGrit IG5236? It's a multi-core controller with NVMe 1.4 support, eight memory channels, and a quad-lane PCIe 4.0 interface. Like the Phison E18, it's built on TSMC's 12nm FinFET process, which bodes well for things like clockspeeds, thermals, and efficiency.

Of course, merely being novel isn't going to cut it. Nor is multiple gigabytes of bandwidth in each direction. The SSD market is thick with PCIe Gen 4 drives that can hammer out huge numbers.

That said, the headline speeds do look pretty decent, what with 7,400MB/s claimed reads and 6,800MB/s writes. What's more, the InnoGrit chip supports both SLC caching and DRAM cache.

In this implementation, you get 666GB of SLC cache and 2GB of DDR4 DRAM cache. All thoroughly competitive, if a little devilish, so far.

If it's chinks in the armour you seek, however, there are a few. For starters, the drive's peak IOPS are quoted at 650K for reads and 740K for writes. That's a little off the one-million-IOPS pace set by several drives here. Similarly, the 1,480TB of claimed write endurance is fully 1,000TB behind the very best.

In both cases, you could argue that kind of on-paper comparison doesn't mean much in the real world. That's especially true of the write endurance rating. Do the math and it works out to 810GB of writes each and every day for no fewer than five years. That's got to be enough for almost anyone. Speaking of five years being enough, that's how long the warranty is, too.

While we're having a go, you could also argue that the Gammix S70's NAND chips are a little old hat, too, being Micron's 96-layer TLC output rather than the very latest 176-layer items. But what really matters is how this thing performs – and the XPG's performance can be reasonably described as pretty stellar.

How so? Well, it's the fastest drive here by several metrics. It has comfortably the quickest sequential read speed at 7,451MB/s, while its sequential writes are only a little off the pace at 6,793.

Arguably even more impressive is the S70's 4K random write performance, given 4K throughput is both so much harder to achieve than sequential and arguably has more impact on the actual feel of your PC. At 262MB/s, it's the quickest on test.

Just a little less impressive is the 4K read result of 74MB/s. 2,879 points in PC Mark's storage test doesn't exactly set the benchmark table alight, either. The operating temperature under load of 67°C is arguably a little warmer than we'd like, too, especially considering that big heatsink.

So, this drive is a very strong, but not quite flawless performer. If the only metrics that mattered were pure performance and anticipated longevity, the XPG Gammix S70 would be a decent contender for your money, but probably not an outright winner. But there's one more dimension to consider. And that's the price.

At pretty much $150 less than the other two 2TB drives on test, this SSD represents outstanding value. Money no object, we'd go for the Seagate drive. However, money is an object for most people, including us.

If the price is a consideration for you, too, the Gammix S70 is easily close enough to the Seagate in every other regard for its reasonable price tag to push it over the line.

Strong performance in many metrics plus stellar value for money, though runs a little warm.

★★★★½

The final reckoning

Six speedy M.2 SSDs. A pile of benchmarks. And a whole hill of specs. But what have we learned? Firstly, the quality of current SSDs is very high. There absolutely isn't a dud here. Every single drive would be an electrifying upgrade for a system based on something like an old SATA SSD. Indeed, it's remarkable to think 7GB-plus per second of bandwidth is rapidly becoming the norm. You don't have to be old to remember when that kind of bandwidth was decent for a CPU, let alone storage.

If there is a disappointment it involves 4K random access performance. It's those tiny little data requests and writes that can make the difference to how snappy your PC feels in regular use. While random access throughput has improved thanks to a big uptick in IOPS or Input Output Operations performance, 4K performance is still miles off sequential throughput and not progressing at the same pace. To put that into numbers, these PCIe 4.0 drives are well over ten times faster for sequential performance than a good SATA SSD, but more like three to four times quicker for 4K throughput.

And remember, the arrival of PCI Express 5.0 drives won't automatically do anything to change that. Intel's Alder Lake CPUs already have PCIe Gen 5 support and AMD is expected to add it when the new Ryzen 7000 chips appear later this year. But all Gen 5 will guarantee is increased headroom for double the maximum theoretical throughput. OK, 16GB/s of potential storage bandwidth sounds bonkers. But we'd rather see the 4K grunt increased, given the choice.

Another issue worth noting is that SSD performance arguably doesn't have a huge impact on game level load times, as our *Final Fantasy XIV: Shadowbringers* benchmark results show.

Indeed, a certain well-known YouTuber recently lined up a row of PCs running games fed via everything from an old SATA SSD to the latest and greatest NVMe M.2 drive. In a blind test, it was clear that nobody could reliably identify what was ostensibly the much faster storage subsystem.

The caveat to that is the possible impact of Direct Storage, a technology first seen on the Xbox Series X and due on the PC imminently. The details of how it works are a story for another day. But it could make really high-performance storage far more important for PC gaming than ever before.

That aside, the gaming thing just serves to underline how important value is. In subjective terms, we think it would be a struggle to tell any of these drives apart, day to day, for almost any task, not just gaming. They are all very quick SSDs with quality TLC NAND, not nasty QLC stuff, eight memory channels, quad PCIe 4.0 lanes, plenty of DRAM cache, all the good stuff.

With that in mind, price matters an awful lot. That's why the XPG Gammix S70 2TB impresses so much. $459 isn't throwaway money. But you get so much for it, namely 2TB of seriously fast storage. Not only does it make the more expensive competition look largely redundant. It makes current graphics card pricing seem positively insane.

We can remember way back to the early days of solid-state storage on the PC, to playing with stuttering pre-TRIM Intel drives measuring a few tens of GB and wondering when it might be affordable to have lightning-fast solid-state drives for mass storage. That day has surely come with the likes of the XPG Gammix S70. Genuinely affordable and stupidly quick, it's all the SSD almost anyone could ask for right now. ■

It's remarkable to think 7GB-plus per second of bandwidth is rapidly becoming the norm. You don't have to be old to remember when that kind of bandwidth was decent for a CPU, let alone storage.

BENCHMARKS

SSDs by the numbers

		Synthetic performance - ATTO Disk Benchmark		PCMark10 Storage (full)		
	APC Labs ranking	Peak Sequential Read (MB/s)	Peak Sequential Write (MB/s)	Index	Bandwidth (MB/s)	Average Access Time (µs)
Crucial P5 Plus 1TB	4	6,390	4,660	3,140	498	[illegible]
Kingston Fury Renegade 2TB	3	6,860	6,440	3,177	[illegible]	[illegible]
PNY XLR8 CS3140 1TB	5	6,820	4,890	2,683	409	72
Samsung 980 Pro Heatsink 1TB	6	6,230	5,080	2,746	431	60
Seagate FireCuda 530 2TB	2	6,940	6,410	3,021	487	56
XPG Gammix S70 2TB	1	6,950	6,340	2,879	458	58

In our previous testing, it cranks out a whisker over 90MB/s for reads and well above 300MB/s for writes, which would put it at the top of the table.

Not appearing in this Group Test.

ABSENTEES

With any group test, there's always the ones that got away.

It was always going to be that this group test didn't encompass the bulk of the products available. After all, the market is positively heaving with options, all of them seriously speedy.

The most conspicuous absence has to be the WD Black SN850. The 2TB version can be had for around $549, which puts it right in the XPG Gammix S70 2TB's wheelhouse. But the SN850 has some conspicuous performance advantages. As you'd expect, it puts out really big sequential numbers. But so do all the other drives.

Instead, it's the trickier – and arguably more critical for that sense of day-to-day response and performance – 4K random performance where the WD Black SN850 makes its mark.

In our previous testing, it cranks out a whisker over 90MB/s for reads and well above 300MB/s for writes, which would put it at the top of the table. Notably, it also outscores every drive here in PC Mark's Storage benchmark.

To be frank, it makes the pricey Phison-based SSDs look a tiny bit silly. It's hard to imagine why you'd pay loads more for one of those when the excellent WD Black can be had for so much less.

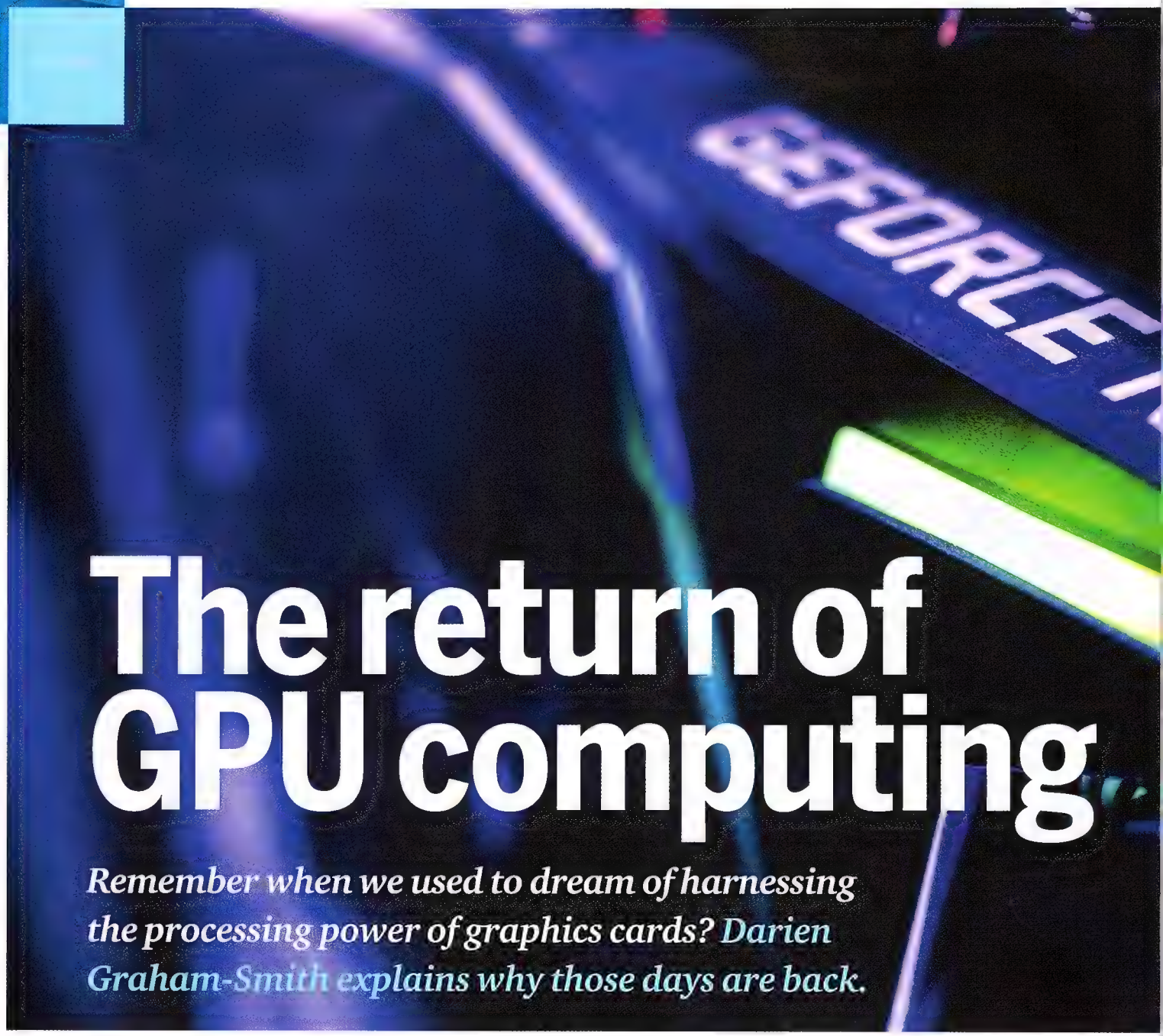
It's not perfect, of course. You could argue that its 96-layer SanDisk TLC NAND memory is a little long in the tooth. The SN850 also looks a little off the pace for sequential write performance.

Aside from that, we did have two new Gen 4 SSDs arrive in the Labs well after this group test was completed and the magazine pages were complete. It was very close to our deadline so we decided to do these two as stand-alone reviews in this issue.

Those are the the new MSI Spatium M480 Play and you'll find that on page 37 of this issue. It turned out to be yet another fine showing from MSI, which is a new player in the SSD market and has thus far been extremely impressive.

Our second latecomer is the Silicon Power XS70, and the review for that is on page 39. Silicon Power is relatively new to the Australian market, and we've concluded that this is a brand to watch and consider.

Peak Temp	CrystalDiskMark 7.0.0				Final Fantasy XIV Shadowbringers
Temperature (°C)	SEQ1M Q8T1 Read (MB/s)	SEQ1M Q8T1 Write (MB/s)	RND4k Q1T1 Read (MB/s)	RND4K Q1T1 Write (MB/s)	Total Loading Time (seconds)
69	6,854	5,000	69	174	11.321
44	7,344	6,897	83	247	11.2
36	7,036	5,230	72.2	251	11.6
53	6,668	4,936	86	200	11.3
41	7,334	6,874	83	251	11.4
67	7,451	6,793	74	262	11.4



The return of GPU computing

Remember when we used to dream of harnessing the processing power of graphics cards? Darien Graham-Smith explains why those days are back.

In 2008, GPU computing was supposed to be the next big thing. Before that time, we had always been held back by the limitations of our CPUs, while the vast power of our graphics hardware sat idle. Now the era of the general-purpose GPU had arrived, and hardware that had previously been dedicated solely to animating Lara Croft and her adversaries could now be used to speed up desktop applications and OS processes across the board.

That was the idea anyway and there was some solid sense behind it. While a typical CPU of the time might have had two or four cores, popular graphics cards such as the Nvidia GeForce 9800 GTX were shipping with 192 silicon cores all running in parallel. This represented an awful lot of untapped horsepower.

But not all cores are created equal. The processing units on a graphics card are designed to handle a limited set of mathematical operations – specifically the ones used in rendering 3D scenes. That simplicity is what makes large numbers of workloads comparatively affordable.

It also means that you can't just run any old program on a graphics card. The code would need to be assembled in a completely different way in order to run on GPU cores. That's a complex undertaking – or it was until the big names in graphics stepped in to make GPU computing accessible to anybody.

It started with the arrival of CUDA in 2007, a framework created by Nvidia that allowed programmers to write code in familiar languages such as C++ and Python, and compile it to run on an Nvidia GPU. A year later, Microsoft unveiled DirectX 11, an update to the Windows graphics subsystem that included a new DirectCompute component, again letting programmers send workloads to the GPU without having to worry about the complexities of re-factoring their code to suit the architecture.

Apple, meanwhile, handed over its OpenCL project to the multi-party Khronos Group, providing a free-to-use cross-platform GPU computing framework that quickly came to support a huge range of graphics hardware on the Mac, Linux, Windows, and Android systems.

So what happened?

GPU computing seemed like a fantastic idea – a way to get a huge performance boost from hardware that was already installed in many people's computers. Marketing gurus told us that, when choosing our next computer, we would see the GPU as equally important to the CPU. But, in practice, GPU

computing didn't revolutionise our day-to-day computing experiences and most of us soon forgot about the whole thing.

The reason is that, even with the benefit of CUDA and DirectCompute, GPUs are quite limited. CPUs make use of caching, pipelining, branch prediction and other sophisticated technological tricks to process complex code at incredible speeds. GPU cores, by contrast, are basically what's known as stream processors, designed for straightforward serial processing. If you tried to run something like a multi-tabbed web browser on a GPU core, it would almost certainly be appallingly slow.

Conversely, the big strength of GPU cores is that there are so many of them. This allows for massively parallel computation: if you have a very large set of numbers to process, a GPU can be orders of magnitude faster than a CPU. Unfortunately, this simply isn't something that every program can benefit from: when CUDA was initially launched, it specifically targeted Big Data analysis and video processing applications. We were invited to assume and hope that the technology would soon spread to other aspects of computing, but Nvidia wisely didn't make any promises on that front.

Who needs GPU computing?

Today, contrary to the predictions of the early days of GPU computing, some of our recommended laptops and productivity desktops don't have a dedicated GPU at all. That's because, outside of games and specialist data-processing tasks, the most common role for GPU computing is video encoding and decoding – and for the past ten years, both AMD and Intel

Cryptomining

Aside from gaming and creative applications, there's one other role to which graphics cards are uniquely well suited: cryptomining, the process by which individuals can generate bitcoins and other cryptocurrencies.

The reason why graphics cards are so good at this job isn't hard to understand. To earn bitcoins, you need to solve a complex "hashing" problem. There's no known way to do this quickly: you just have to guess a number, apply a mathematical transformation and see if the right answer comes out. The difficulty level goes up and down depending on how quickly the last answer was found; at the time of writing, it was at around 25,000,000,000,000, meaning each guess has a chance of approximately one in 25 trillion of being correct.

If you're using a CPU to do your hashing, you can try a lot of numbers pretty quickly: the 24-core Intel Core i9-10920X can test more than 5,320 hashes per second. But that's nothing compared to a top-of the range graphics card. The GeForce RTX 3090, with more than 10,000 CUDA cores, can rip through 120,000,000 hashes every second. If you leave it running then, at current market rates, it should earn you around $10 per day in bitcoins, or more if you're canny about speculating in other cryptocurrencies.

That might not seem like an amazing return on investment, and it's not great for the environment. But the competitive edge has seen crypto-enthusiasts snapping up recent RTX cards, resulting in a months-long stock shortage and sky-high prices on the secondhand market. The RRP of the GeForce 3090 RTX is already decidedly steep at around $2,800, but if you want to buy one today your only option might be to go to eBay and pay double.

In a bid to calm the situation down, Nvidia announced in February that it was introducing "hash-limiting" firmware to various RTX models, which deliberately slows down cryptocurrency hashing functions without affecting other operations. It's probably the only instance in history of a graphics company taking steps to deliberately diminish the power of GPU computing – though to compensate, the company has launched a separate CMP range of cards designed specifically for mining.

How much faster is a GPU?

It's impossible to put a figure on the benefits of a GPU. There's a wide range of different models on the market, for both desktop and laptop systems, and lots of different CPUs to compare them to.

Needless to say, different tasks will see considerably different benefits. To illustrate what you might experience, however, we carried out three benchmarks on a Windows desktop system equipped with a Core i7-8700K processor, 16GB of RAM, and an Nvidia GeForce RTX 3060 Ti graphics card. The CPU features six cores with a base clock speed of 3.70GHz, while the card has 4,864 CUDA cores running at 1.76GHz, plus 152 tensor cores and 38 ray-tracing cores.

For our first test, we downloaded the open-source 4K movie *Tears of Steel*, imported it into DaVinci Resolve Studio, reorganised some scenes to create our own "director's cut" then timed how long it took to render the output as a 1,920x1,080 H.265 file, using first Nvidia CUDA acceleration and then Intel's CPU-based Quick Sync encoder. As you can see, the GPU's massively parallel design provided a measurable performance boost over processor-based rendering.

Next, we turned to Photoshop, introduced at the end of last year. Adobe's neural filters use AI techniques to apply intelligent image transformations; we used the Super Zoom feature to enlarge a section of a 20MP image, while interpolating detail to keep everything looking sharp and smooth. In this case, the Nvidia card's tensor cores accelerated the process to the point where it wasn't too painful to interactively experiment with the controls and see how different settings affected the results – something we wouldn't have liked to try on the CPU.

For our final test we fired up the Blender 3D modelling package and loaded the free BMW demo scene. After setting it to render on the CPU, Intel's, we waited for nearly five minutes for the finished image to appear. By contrast, the graphics card's dedicated ray-tracing hardware helped it to turn out the complete 3D scene in just 44 seconds.

Not every workload will see this type of performance boost, but it's one heck of a demonstration of what GPU computing can do – and there's certainly potential for a wider range of tasks to benefit in the future. Casual hobbyists may not be able to justify the $830 cost of the card, but for anyone whose livelihood depends on their productivity and their creative capabilities, it's a tempting proposition.

Top: Nvidia's Studio platform aims to speed up processes for creative pros. **Above:** Farms of graphics cards working in parallel are now common.

DaVinci Resolve Studio 1080p video encode

Photoshop Super Zoom filter

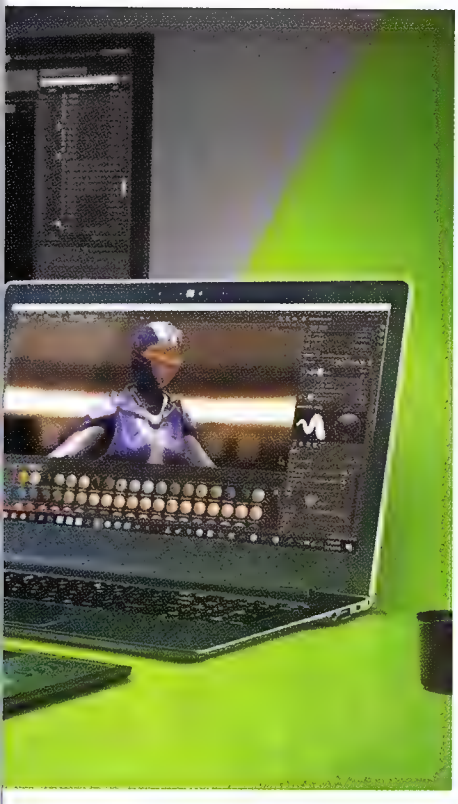
Blender 720p render

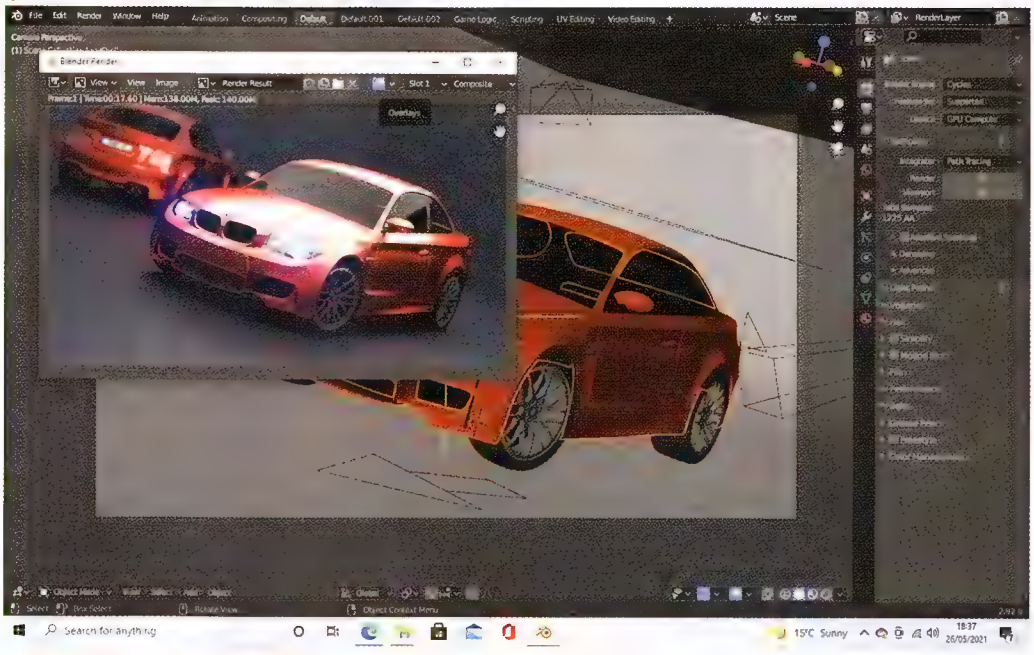
processors have included specialist silicon dedicated to these particular tasks as part of their integrated graphics units. We've been getting GPU computing, as it were, for free.

As you'd expect, these functions are comparatively lightweight: encoding performance isn't up to Pixar standards. Still, decoding on all recent chips is fast enough to smoothly play 4K HDR video files in a variety of popular formats, and very few people need more than that. In other words, aside from gaming performance, the typical Windows user loses little by making do without a graphics chip.

So who does benefit from GPU computing? The answer is, lots of people who work in the graphic arts – from architecture to 3D animation, from visual effects to game design. These are the areas where the innate graphical power of a modern graphics card can really be used for productive purposes – and for this reason, in 2019 Nvidia launched its "Nvidia Studio" brand, which targets GPU computing directly at creative professionals.

This manifests primarily as a sticker on a laptop or graphics card, confirming that the hardware





delivers a certain standard of creative performance. GPUs within the Studio programme are supported by the likes of 3ds Max, Autodesk Arnold, Blender, RedCine-X Pro, Unreal Engine, and numerous Adobe applications, including After Effects, Dimension, Illustrator, Lightroom, Premiere Pro, and Photoshop.

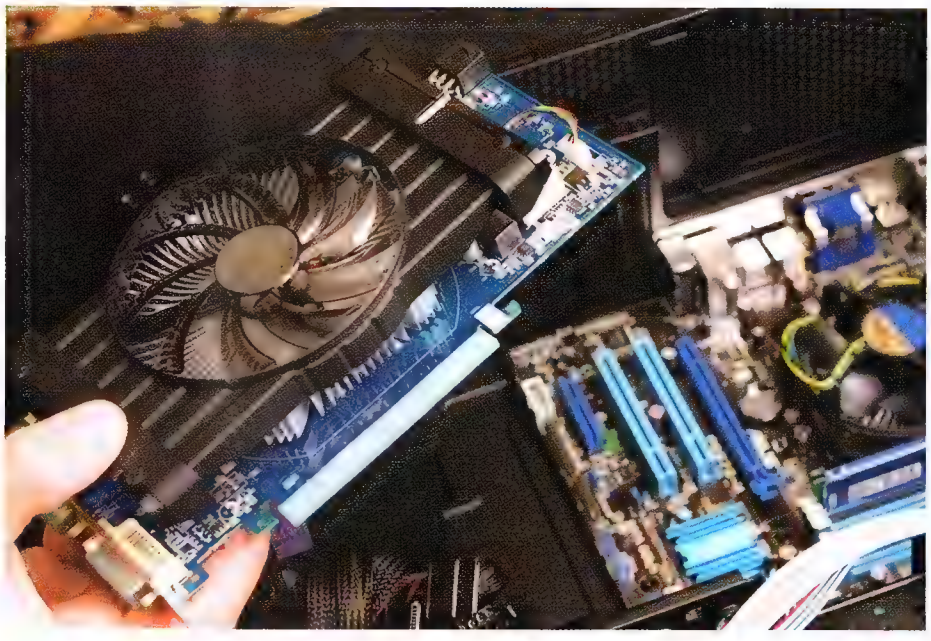
These programs still run mostly on the CPU, but specific functions – such as rendering scenes, encoding video, applying visual transformations and just panning around a canvas – are accelerated by the graphics card. Some features, like Photoshop's 3D transformations, won't work at all without a supported graphics card.

On that note, it's worth being clear that many of these functions can also be accelerated by non-Nvidia graphics hardware, using OpenCL instead of CUDA. However, Nvidia's recent cards feature additional hardware that extends the boundaries of GPU computing.

From GTX to RTX

As we've mentioned, the massively parallel architecture of a standard graphics card can be enormously powerful with the right type of workload – but it's limited as to what jobs it can efficiently do. In 2018, Nvidia released a new graphics core, dubbed "Turing", that extended the design by adding dedicated ray-tracing units and maths processors of a new type called a tensor core. GPUs with these features have an RTX model number, as distinct from the old GTX designations.

When creatives are working interactively with 3D scenes – or when gamers are campaigning through virtual worlds – the ray-tracing units make it possible to include realistic details such as reflections and shadows, which would have been too slow to render in real-time using older hardware.



Above: Ray tracing appeals to gamers who appreciate realistic scenes... **Top:** ... as well as to designers trying to create realistic 3D models.

The tensor cores are more complicated. In mathematics, a tensor is like a matrix that describes the relationship between multi-dimensional sets of numbers. The tensor cores, correspondingly, carry out operations on whole multi-dimensional sets of numbers at once. This is vastly more efficient than working through the calculations one by one, or trying to share out the work across a bank of stream processors.

And what's it used for? Well, Nvidia semi-officially refers to these as "AI cores" and describes them as "an immediate path to faster training and greater deep learning performance". In other words, it's our old friend, machine learning. This opens up a whole world of potential for data scientists, but it can also be useful for visual artists: AI-based rendering and graphics enhancement can produce exceptional results in a fraction of the time it would take using traditional methods.

Even audio applications get a look in: a plugin called RTX Voice uses AI, powered by the tensor cores, to remove background noise from online broadcasts and chats.

At the moment, no other GPU manufacturer has anything to compete with Nvidia's RT and tensor cores: if you work in an app that takes advantage of them, you may well conclude that GPU computing is a revolutionary technology after all. ■

30 WAYS TO MAKE YOUR PC BETTER

PC repair expert Lee Grant reveals dozens of ways to pep up your computer – and a few ways not to.

There's always room for improvement where technology is concerned, and I'll bet that your PC is no exception. I've pulled together 30 tech tips to deliver improvements to most desktops and laptops, both state-of-the-art and straight-off-the-Ark. There are simple software solutions that could unlock that performance bottleneck, alongside some hot hardware tweaks if you fancy getting the screwdrivers out. As an *APC* bonus, there are also three things not to do, as they're a waste of time and money.

01 Don't double up on security

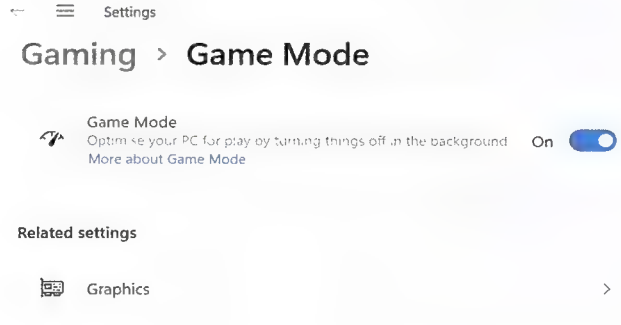
There is such a thing as too much protection, and it's not uncommon to see machines struggling to juggle multiple security suites. There isn't one rule for everyone where antivirus is concerned, but here are a few things to think about.

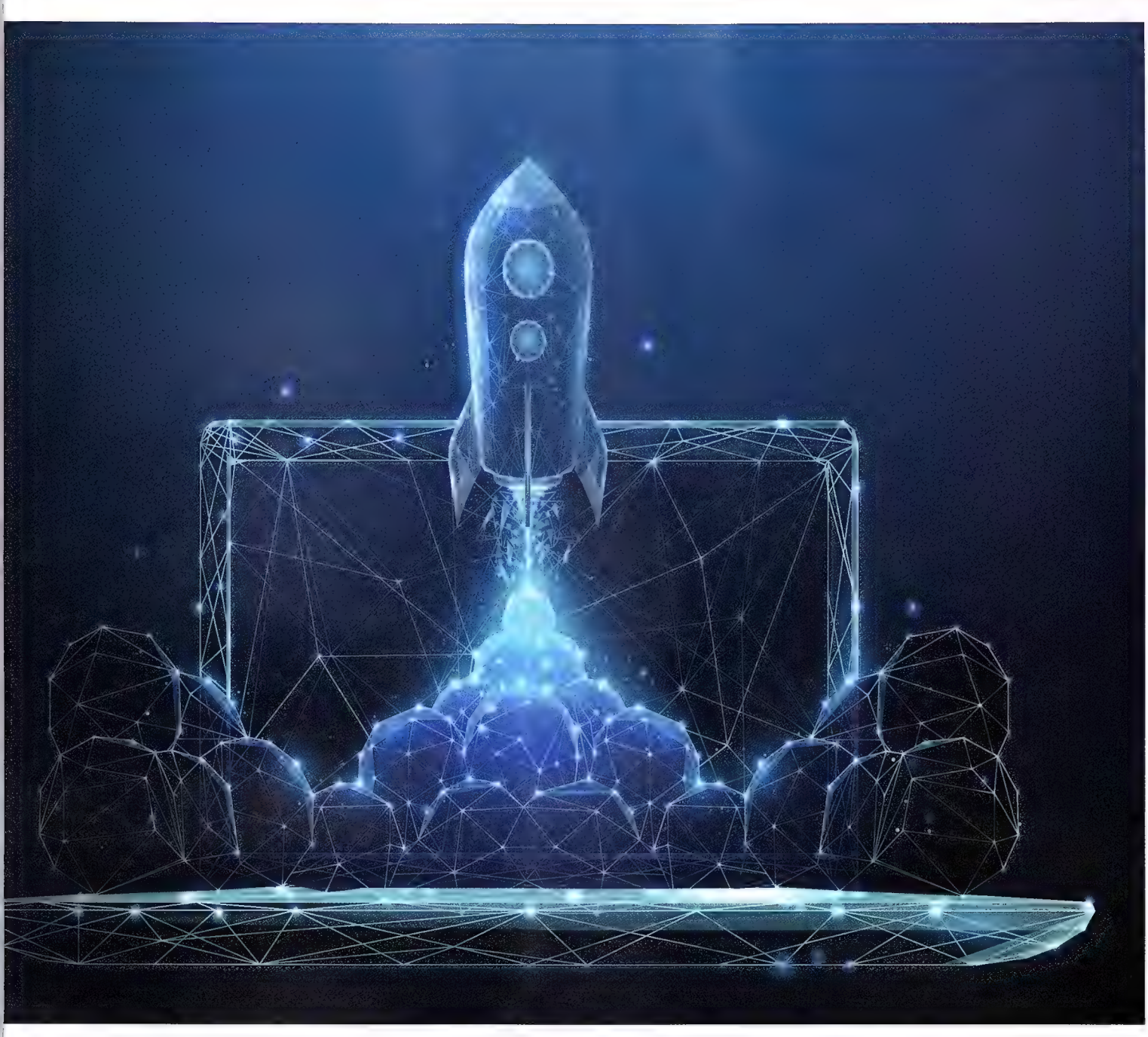
Uninstall products with trial or expired subscriptions as they'll hog resources while supplying sub-optimal protection. If you want to run up-to-date products from different vendors (AV from one, malware protection from another), then make sure there's no crossover. Internet security products can be extremely resource-heavy, so lightening the load can really benefit performance.

02 Turn on Game Mode

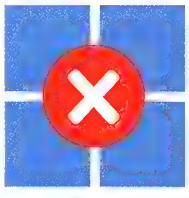
Microsoft designed Game Mode to streamline gaming experiences by suspending notifications and updates. Sadly, it didn't work as expected, and many gamers simply switched it off.

Microsoft has beavered away and fixed the issues, so it's now safe to switch it back on. Game Mode in Windows 11 has new functionality to assign GPUs to specific apps, so on those trips away from mains power, you can preserve battery on a





multi-GPU laptop by assigning *Among Us* to the on-board graphics, while keeping the high-powered chip asleep.



03 Do not update to Windows 11

If your machine has passed the 11 test, still think carefully before pushing the upgrade button. Windows 11 has innovative features designed to optimise Intel's 12th Gen Alder Lake chips and improve gaming performance with DirectStorage caching, but for many PCs – particularly low-powered machines – it currently performs slower than Windows 10. If you don't have a burning desire to use a Windows 11-only feature, it may be worth waiting until Microsoft's latest picks up speed. Or your next hardware refresh.

04 Replace any spinning disks

The era of PCs with spinning hard drives is over, and solid-state drives (SSDs) are the baseline, even at the budget end of the market. Installing an SSD is a simple task, and it's the nearest thing to a waving a magic wand that I can recommend. As SSD technologies have matured, prices have dropped considerably, but don't buy a 1TB SSD if your current spinner only has 90GB of data; save the cash for something you'll use. Look for M.2 NVMe sockets on the motherboard for maximum performance boost.

05 Dump old software

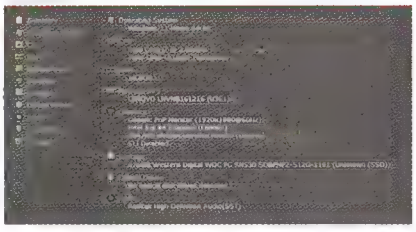
Windows 10 has a long tail, and

6 RAMP UP THE GRAPHICS

It's an expensive time to be buying GPUs, but if you happen to know what you're looking for then reasonably priced cards can be found in the refurbished or second-hand markets.

Before splashing out, use a PSU calculator (such as the one supplied by Cooler Master at **coolermaster.com/power-supply-calculator/**) to ensure that your current PSU will power the new card. Also perform a visual inspection inside the case to check that there are enough PCI power connectors available and that the dimensions of the GPU won't foul against other cards, panels or connectors.

many current machines began life using Windows 7 back in 2012. Long-life machines are often ladened with abandonware that really must go. I'm not suggesting that all old software is problematic (I'm a proud Fireworks 6 user), but there are risks. Software that hasn't been updated could present security concerns, so uninstall anything that's unused and give the machine's resources to things that you do use. If you're clinging to ancient software, then research modern alternatives while it still works. Whenever Windows 14 arrives, it may refuse to entertain your old favourite.



07 Investigate CPU upgrades

CPU upgrades remain an amazing way to give your machine real grunt. AMD's AM4 socket accepts a broad range of Ryzen chips, and even Intel systems are worth investigating. Once Speccy (**ccleaner.com/speccy**) has revealed which motherboard is powering your PC, head over to the relevant manufacturer's website to reveal the possibilities. Flash the BIOS (if necessary) before you swap chips and be mindful that a more powerful cooler may be required. Costs can be offset if your old CPU has resale value.

8 FIX NOISY FANS

In an era of PCs with few moving parts, the noisy culprit is usually a fan. There may be more than one inside your desktop (there's normally only one in laptops), so trial and error will reveal the offender.

Often the solution is no more complicated than giving them a good (yet careful) clean, and many desktop fans are constructed so that it's possible to re-lubricate the spindle. However, if you crave a quieter life, replacing the stock fans with low-noise alternatives is the way to go.

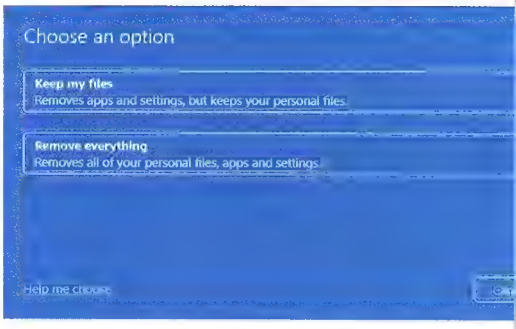
09 Encrypt your PC

PC security isn't something that only corporate IT managers need worry about. If your machine goes walkabout, knowing that the data is encrypted is one less thing to worry about. Encryption on Windows is super easy thanks to BitLocker, but it isn't available for the Home editions.

10 Move out the motherboard

Upgrading a motherboard is a simple way to bring desirable features to your PC. Switching boards can introduce additional RAM slots, improved VCORE power delivery and connectivity technologies such as Thunderbolt.

Compatibility is the key to success, so


Choose an option
Keep my files
Removes apps and settings, but keeps your personal files.
Remove everything
Removes all of your personal files, apps and settings.
Help me choose

ensure that you know exactly which permutation of CPU and RAM is in play and use this as a guide for the new motherboard.

Bonus tip: An enthusiastically purchased ATX board won't fit in an mATX case, no matter how much coarse language is used. Check the dimensions.

11 Reset the PC

Full factory resets are not just for when things go wrong. PCs collect junk files, broken Registry entries and legacy processes that can suck the performance from a unit. It's possible to scour log files and correct errors, but it's far easier to reset the machine. Before you begin, plan a strategy of how you'll reinstall apps, re-introduce passwords and restore the data. MyKeyFinder 2021 can help you dig out your licence keys too.

12 Remove junk trials

Many machines are pre-loaded with "software you'll love", but let's be frank, cash has changed hands to have this stuff pre-loaded onto your box. If you're not using it, get rid. Unused apps will integrate into Windows Update, slowing the cycle and consuming data for no reason. Work your way down "Apps and Features" in Settings (or "Programs and Features" in the Control Panel) and cut the dead wood.

13 Make the Wi-Fi fly

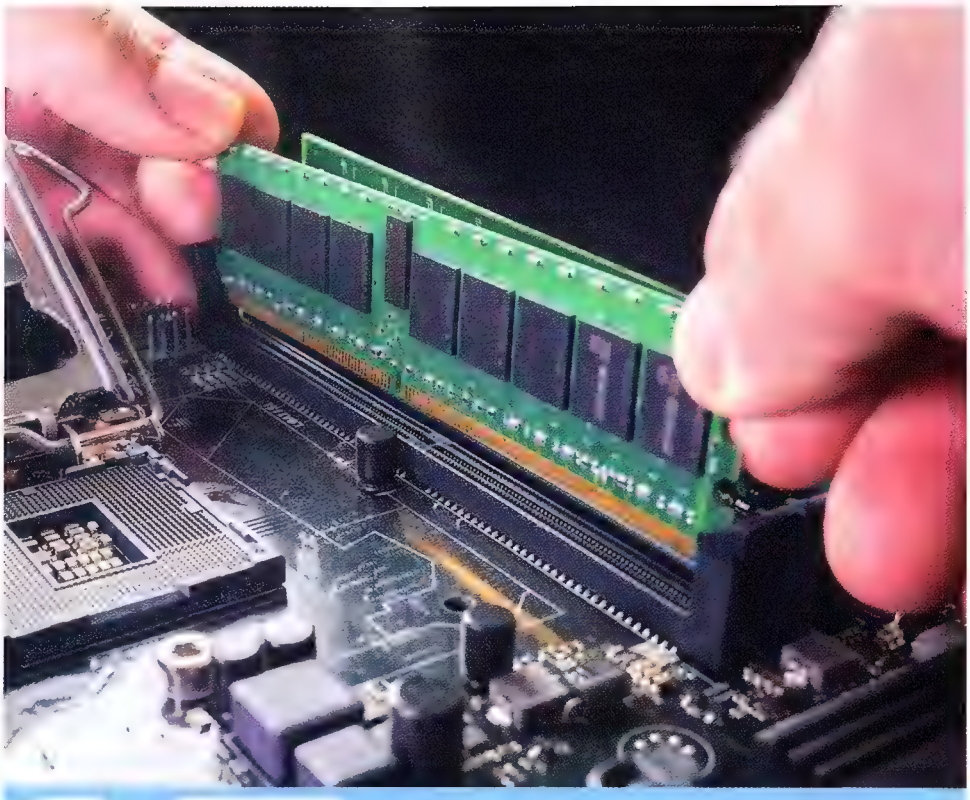
If your wireless speeds leave you lagging, then it's time to swap hardware. Wi-Fi adapters are reasonably cheap, and if you don't fancy getting out the screwdrivers, USB adapters compatible with Wi-Fi 6 are now available. It's possible to switch out the internal Wi-Fi modules on a laptop, but certain brands block this with a BIOS "approved" list. In certain cheaper machines, I relate poor speeds to sub-standard aerials, so USB or PCIe alternatives with decent-sized external antennas should turbo-charge the connection.

14 Enable browser sync

We store a lot of information in our web browsers and, thanks to some of the fabulous plugins available, we customise them to our particular needs. Browser synchronisation is the easiest way to ensure that this setup isn't lost when different machines come into your life. All major browsers can sync passwords, history, add-ins and even open tabs across multiple devices, including tablets and phones. Nothing ruins the new PC experience like a bare browser, and sync is the simplest way to ensure this doesn't happen.

16 Tighten the screws

This tip is ridiculously simple, free, easy to execute and can genuinely prevent laptop destruction. Ready? Grab screwdriver, flip laptop, tighten screws. That's it, done, mine's an Irn Bru! Here's the science bit. Each time the laptop lid opens, the twisting forces being exerted on the hinges and chassis are immense. Screws preserve the laptop's rigidity and alignment of the moving parts, but when they loosen during transit, it's a matter of time before the screen comes off in your hand. If you have missing screws, replace them.



11 BOOST THE RAM

Upgrading the RAM certainly warrants investigation, especially if the machine is lethargic. RAM doesn't give the performance gains of an SSD switch, but if your apps lag when the pressure is on, more resources are the way to go. RAM comes in many forms, and if you're not sure what to buy, consult your local friendly computer shop or head over to Crucial (**crucial.com.au**) or Kingston (**kingston.com**). Sadly, not all machines have upgradable RAM, especially laptops.

18 Switch on XMP

It's worth investigating if the system's RAM is working at advertised

17 BUY A NEW WEBCAM

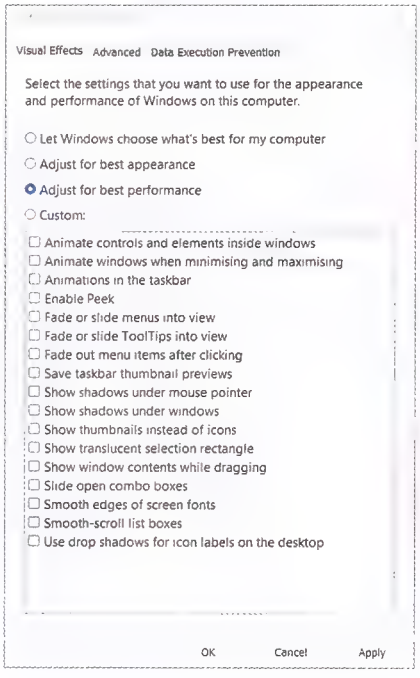
Five years ago, most people didn't care about the quality of their webcams, which was fortunate because most were awful. It's still a gamble today, with many reasonably expensive machines using low-resolution cameras with desaturated colours and a microphone that only reacts to loud explosions. Shelves are now stacked with USB replacements with superb resolutions, headphone ports and adjustable heads. Most clip to the top of your screen, but models with their own tripod and light ring are plentiful. A clip-on mic is also money well spent.

speeds. Your machine may have 3,200MHz DDR4 installed, but if the setup wasn't perfect or the BIOS has suffered a blip, it may be running at default speeds around 2,400MHz. Enabling XMP (Extreme Memory Profile) in the BIOS forces the motherboard to read the RAM's timing profiles and auto-tune the system accordingly.

Although XMP is an Intel technology, you'll find it on many AMD boards. It's also known as DOCP, AMP or EOCP.

19 Reduce Windows FX

Windows 11 has upped the graphical pizzazz for everyone's desktop, but if you can live without transparency effects, then switch them off for a quick performance boost. In Windows' Accessibility settings, select Visual effects, then disable Transparency effects and Animation effects. Next, bring up Advanced System Settings and click Settings under Performance. Select Adjust for best performance and Windows will switch off a stack of cosmetic enhancements. Your PC won't have a massive injection of speed, but the tweaks certainly make the interface snappier.


Visual Effects
Advanced
Data Execution Prevention
Select the settings that you want to use for the appearance and performance of Windows on this computer.
Let Windows choose what's best for my computer
Adjust for best appearance
Adjust for best performance
Custom:
Animate controls and elements inside windows
Animate windows when minimising and maximising
Animations in the taskbar
Enable Peek
Fade or slide menus into view
Fade or slide ToolTips into view
Fade out menu items after clicking
Save taskbar thumbnail previews
Show shadows under mouse pointer
Show shadows under windows
Show thumbnails instead of icons
Show translucent selection rectangle
Show window contents while dragging
Slide open combo boxes
Smooth edges of screen fonts
Smooth-scroll list boxes
Use drop shadows for icon labels on the desktop
OK
Cancel
Apply

20

LAPTOP SCREEN UPGRADE

Many laptop owners wish their screen was sharper, particularly with older or budget machines factory-fitted with WXGA resolution panels (1366 x 768 is a common resolution). Open the screen up and note the location of the mounting lugs and the position of the connector, while counting the pins (20, 30 or 40). Full HD (1920 x 1,080) replacements are available for a reasonable cost (higher resolutions may require additional wiring that the machine doesn't support), but this tip is also useful if you want to swap a super-shiny gloss screen for a matte finish or vice versa.

21 Replace the case

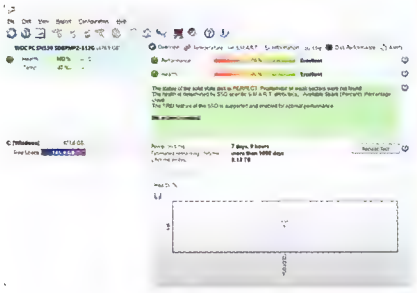
Fantastically expensive components are often crammed into cheap cases and, aesthetics aside, a better-quality box may result in a better PC. Annoying rattles are greatly reduced by cases built to higher standards as thicker metals are more rigid and resist vibration. If noise is a bugbear, manufacturers such as Be Quiet (**bequiet.com**) are a wise investment. Additionally, new cases open possibilities for water-cooling rigs, extra drives, updated connectivity and fan/lighting controls on the front panel.

22 Use SSD software

SSDs are stonkingly good, getting PCs from cold starts to open apps in moments, but when faults occur, drive health plummets. Most SSD manufacturers supply management software to flag issues and adjust performance, enable over provisioning and update the firmware. Alternatively, Hard Disk Sentinel (**hdsentinel.com**) gives visual indicators for drive health.

23 Eradicate network throttling

Incorrectly configured network adapters are often the actual cause of slow connection speeds, so if your **Speedtest.net** results are underwhelming, head over

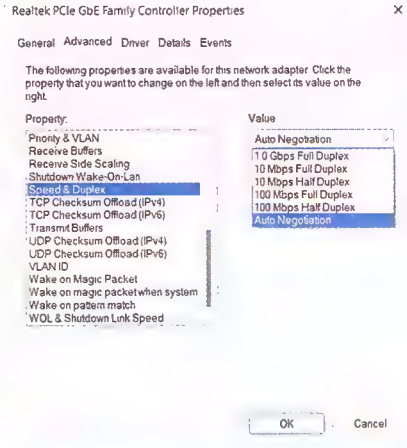


to Device Manager and select your network controller.

Select Advanced and a vast array of configurable options appear. For wired NICs, check Speed & Duplex to ensure everything is turned up to 11. The options for wireless controllers vary with manufacturer, but check Wireless Mode and Preferred Band for starters.

24 Tame the touchpad

If I surveyed my laptop customers, asking them what they didn't like about their device, the touchpad would be high on the list. The technology inside a modern touchpad can bring amazing flexibility and productivity enhancements if you take a few moments to learn the capabilities.


Realtek PCIe GbE Family Controller Properties
General Advanced Driver Details Events
The following properties are available for this network adapter. Click the property that you want to change on the left and then select its value on the right.
Property:
Priority & VLAN
Receive Buffers
Receive Side Scaling
Shutdown Wake-On-Lan
Speed & Duplex
TCP Checksum Offload (IPv4)
TCP Checksum Offload (IPv6)
Transmit Buffers
UDP Checksum Offload (IPv4)
UDP Checksum Offload (IPv6)
VLAN ID
Wake on Magic Packet
Wake on magic packet when system
Wake on pattern match
WOL & Shutdown Link Speed
Value:
Auto Negotiation
1.0 Gbps Full Duplex
10 Mbps Full Duplex
10 Mbps Half Duplex
100 Mbps Full Duplex
100 Mbps Half Duplex
Auto Negotiation
OK
Cancel

Touchpad Settings let you customise how a PC reacts to taps, pinches and multi-finger gestures. Alternatively, you can switch it all off and time-warp your touchpad back 20 years to a strictly up-down-left-right affair. Take time to tame your touchpad.

25 Run diagnostic tests

PCs are fantastically complicated devices designed by geniuses, but they're not invincible. Running a few tests every so often is the best way to detect faults before they cause chaos inside your machine. PassMark MemTest (**memtest86.com**) is a free tool that will put RAM through a barrage of tests (always run it after installing new RAM). SSD manufacturers have downloadable

THREE WAYS TO WIN BY DOING NOTHING

Our 30 tips will make a difference to your PC, but there are some commonly requested tweaks that are a complete waste of time.

HIGHER WATTAGE PSU = FASTER PC

It's an understandable confusion as an 800W power supply unit (PSU) is definitely capable of delivering more power than a 400W unit, but that's not how they work. A PC requires a certain amount of voltage to run and, provided your PSU can deliver enough of it (measured in Watts), then all is well. Fitting a 1,200W PSU to a machine requiring only 300W won't make it go any faster. The machine draws power from the PSU rather than the PSU pushing the power into the PC.

DEFRAGGING AN SSD

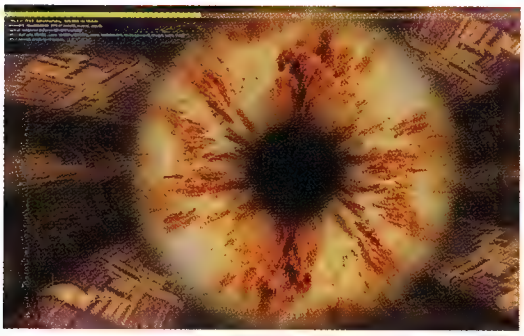
When Windows 98 ruled the world, defragging the drive became a common maintenance routine. The process reunites file fragments into a contiguous block, which is beneficial for spinning drives that lose time by srambling backwards and forwards over a platter, but completely pointless for SSDs, which can access everything at all times. To make matters worse, SSDs have wear-rates (TBW) and the defragging process chews into it. Don't defrag an SSD.

CLICK HERE TO OPTIMISE

Or rather, think before you do. Software optimisers promise much and on certain high-performance, well-maintained machines, a case could be made that running them may, just may, iron out a kink in the PC. When they're installed on low-powered machines that barely have enough resources to run Chrome without stuttering, the whole PC grinds to a halt. Most optimisers I encounter are trials, which hog resources in order to declare, "We've found a temporary file, give us $20 to delete it". If you aspire to running a tidy ship, then Storage Sense within Windows is worth investigating.

DON'T PUT UP WITH POOR BATTERIES

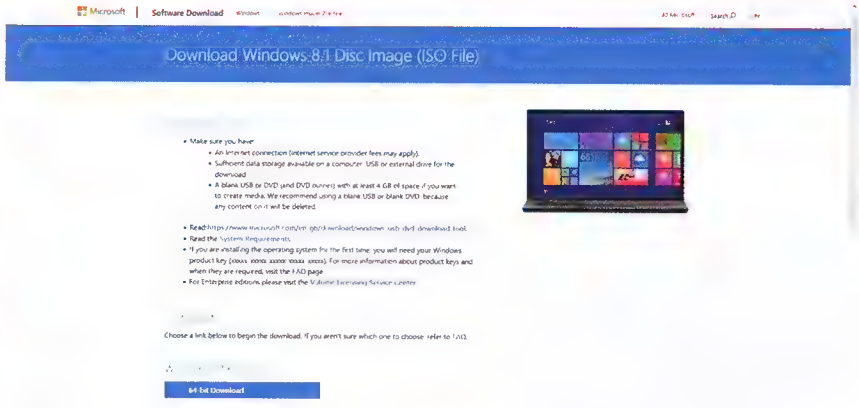
Laptop manufacturers make bold claims about battery longevity but what happens when the battery fails? Some laptops have their own software capable of checking battery life. HP has Support Assistant, Lenovo has Vantage, Acer has Care Centre. Alternatively, BatteryMon from PassMark (**passmark.com/products/batmon**) provides a range of useful information and battery tests. Although laptop batteries are now internal components, they remain a replaceable part. If the manufacturer doesn't sell replacements, try DuracellDirect (**duracelldirect.com.au**), whose 2-Power compatible batteries are ideal for when the OEM ones are no longer available.



tools on their sites to health-check storage, and FurMark from Geeks3D (**geeks3d.com/furmark/downloads**) is useful for stress-testing graphics cards.

28 Interrogate your USB-C ports

Got USB-C? Do you know what it does? Remember, USB-C describes the shape of the port and not its functionality. Is it USB 3.0 running at 5Gbits/sec or USB 3.1 at 10Gbits/sec? It could be USB 3.2 Gen 2x2 (20Gbits/sec) or Thunderbolt. Find out what yours does as a Thunderbolt drive will seem like an extravagant purchase when you discover the USB-C port is wired to a USB 3.0 controller.



29 Phase out old monitors

When was the last time you changed your desktop's monitor? Old LCD panels rarely age well, and sometimes screen flicker, capacitor squeal and a muddy, lifeless image go unnoticed by the day-to-day user. Older monitors may also emit more blue light than new models, which has been claimed to disrupt sleep and disturb circadian rhythms. Keep an eye on our reviews, as we frequently feature fabulous screens suitable for all budgets. Something to think about.

30 Go back to Windows 8

History recalls Windows 8 as a problematic product written off because of an unfamiliar interface. Fair enough, but history forgets that it was also blisteringly fast. I've encountered a few "former-8" machines that haven't reacted well (or at all) to later versions of Windows 10, but a downgrade back to version 8 keeps them running with improved performance.

A disc image of Windows 8.1 is still available to download from Microsoft (**tinyurl.com/APC507WIN8**), while OpenShell (**tinyurl.com/APC507SHELL**) is an option for a better menu.

Extended support for Windows 8.1 ends on 10 January 2023, so enjoy the support, speed and stability while you still can. ■

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Secure your VPN

Jonni Bidwell casts doubt on the highly profitable VPN business, and explains how you can do better.

Consumer VPNs (virtual private networks) are big business. Indeed, if all the sponsored product placement and affiliate linking is anything to go by, then just a few bucks a month will bring you great security, privacy, and other nebulous benefits, while at the same time making you magically appear as though you're in a country of your choosing.

What they don't tell you is that while you're holidaying, safely, in this faraway IP block, your traffic (albeit partly encrypted) is visible to the VPN provider. It might care more about your monthly subscription payment than what you're using its service for, and it might well implement a 'no-log' policy, but the provider has the same insight into customers' traffic as those customers' ISPs did, up until the point it all vanished into a single VPN connection.

We're not saying all VPNs are bad, just that it's difficult to prove that they're all good. So why not run your own? We'll show you how to use the latest WireGuard technology to route your traffic through your home, or the region of your choosing via a Virtual Private Server. And if you don't trust your ISP or VPS provider, we'll look at Tor – the gold standard for privacy.

If your goal is to check out prices in different currencies or to mitigate the risks of public Wi-Fi, then a VPN will help you do that. If your goal is to access geo-blocked content (different Netflix regions or Steam prices, say), then a VPN might help you do that too, but it almost certainly goes against the provider's Terms of Service. Believing a VPN will anonymise your browsing, protect you from tracking cookies, malware and the plague, however, is wide of the mark.

Your IP address is far from the only means companies have of identifying you. We'll see that browser fingerprinting, DNS interception and even good old-fashioned spam can undermine any protections a VPN might offer.

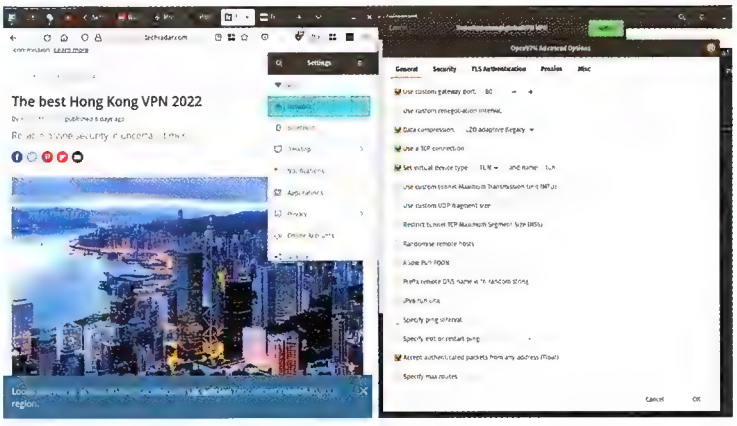
The why and wherefore of VPNs

It's not VPNs that are bad, rather people's unrealistic expectations of privacy. And, in a pay-per-click age, honesty.

Search online for "why I need a VPN" and you'll find flashy websites framing all sorts of shoddy prose on the perils of "unprotected" browsing. Such diatribes should be taken with a pinch of salt. Yes, there are companies that sell your data. Yes, there are brutal regimes that punish anyone caught browsing websites that go against their ideologies. Yes, Google is mostly blocked in China. And yes, a VPN might help you with this. But it's perhaps not as essential as people think.

Anyway, we're getting ahead of ourselves. A VPN is an encrypted tunnel between two, generally distant, machines. There are a variety of protocols by which one can achieve this, but they all enable the client machine to access resources (web pages, VOIP services, internal company resources) using the server as a proxy. Furthermore, established public key cryptography and key exchange protocols are leveraged so that anyone eavesdropping on the VPN connection has an extremely small chance of being able to make sense of the data. And anyone looking at the connection from the VPN server to the outside world (if it's used that way) won't be able to see the client's IP address.

That all sounds quite good – and it is, as long as you trust your VPN provider. Ascertaining that trust, however, is hard. In 2016, a free VPN service called Hola breached user trust. It provided a browser plugin that enabled users to switch regions. However, those users were unwittingly becoming rather more involved in the VPN than they would have liked. Hola's business model at the time was to tunnel traffic between users so that their machines became proxies. This potentially made users vulnerable to all kinds of lawsuits and investigations, since traffic is no longer encrypted after it has left the VPN tunnel. Most of the web is protected by HTTPS now, but that still reveals domain names and IP addresses.



Network Manager supports all kinds of VPN connections, but there are plenty of questionable operations out there.

We'd hope that such behavior is a thing of the past, and for the most part, it is. But that doesn't mean we can trust what these fly-by-night VPNs are telling us. Many of them boast of a 'no logging' policy, for example, yet in 2020, seven such services based in Hong Kong accidentally leaked some 1.2TB of user logs. These included cleartext passwords, session keys, domains visited, browser user agent strings, and IP addresses. NordVPN, for a long time considered more reputable than other services, experienced a data breach in 2018, although no customer data was taken.

These may have been isolated incidents, but would you trust such operations to aggregate all your internet traffic? Or, put it another way, do you distrust your ISP enough that giving that information to an unknown entity seems like a good idea?

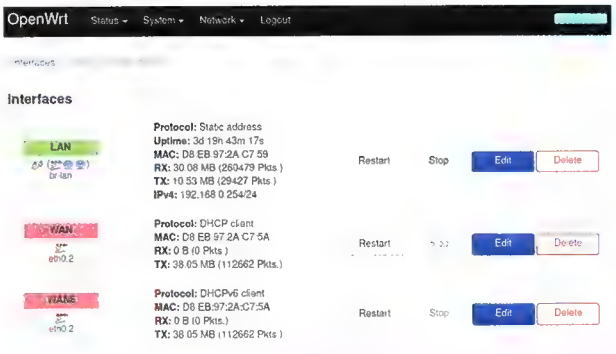
Enterprise and Personal VPNs

As we were writing this feature, a company-wide email appeared with a familiar beginning: "The IT department is investigating an outage".

This time it was the corporate VPN that was out and, since most staff were working from home, they were unable to access corporate services. For us, that meant no fonts, no Creative Cloud license validations, and we couldn't even log into the IT Helpdesk to make them aware of our disgruntlement.

But what we should say is that corporate VPNs are (when they work) a good thing. This, despite using some of the same technologies (for example, OpenVPN) they are used for entirely opposite purposes to the shady VPNs we're on about. Businesses use their VPNs to restrict access to resources and use hardware appliances to achieve this.

Consumer VPNs are more about circumventing restrictions and are run using cheap, commodity virtual private servers (VPSes). It might be easier to rent a VPS from Amazon or Digital Ocean or the like in a data centre, but it's still possible to find boxes in countries where the laws are more relaxed with respect to what can and can't be done with your internet connection. And that's the attraction for many people.



OpenWRT and other open-source router firmware allow you to run a VPN from home.

Run a WireGuard VPN

WireGuard is the newest, leanest, meanest VPN protocol on the scene. Let's get those wires guarded!

Thanks to the wonders of open source, it is possible to run your own VPN. Depending on your purposes (i.e. if you want to break rules), this might not be for you. But if you want a secure tunnel to your home connection or a VPS (virtual private server) when you're away, then we'll show you how.

Before that though, let's look at a lesser-known feature of another jewel of FLOSS, OpenSSH. As it happens it's full of hidden gems. For example, during an SSH session, if you type Enter then ~ then C, you can access a super-secret command shell, from which you can add any port forwarding options. Very handy if you forgot to add them when you initiated the session.

See the box (below) for how to set up a rough 'n' ready not-quite VPN with SSH. Setting up a grown-up VPN is a little harder but, hopefully, we can fit it in the remaining space. WireGuard is still quite new (it was only made widely available in April 2020) and while it aims to be simpler than OpenVPN and others – and architecturally, it is – there's still a lot of manual setup involved.

In the future, there will be additional helpers for dealing with key distribution and IP address allocation, but for now, we'll have to do everything ourselves. WireGuard by design wants to have a minimal attack surface, and as such, it is firmly a network layer service. Things like DHCP (or anything analogous to it that might help WireGuard) exist elsewhere in the OSI stack, so they will never be added to WireGuard itself.

WireGuard far outperforms its peers, according to fetching graphs on its website. It's also simple enough that we can set it up in two pages.

Lay the groundwork

The first thing we need to do is install the appropriate utilities on both machines. First, install the userspace part with:

```
$ sudo apt install wireguard-tools
```

This will create the directory /etc/wireguard into which we'll dump a keypair:

```
$ wg genkey | sudo tee /etc/wireguard/privkey
$ sudo cat /etc/wireguard/privkey | wg pubkey | sudo tee /etc/wireguard/pubkey
```

Since WireGuard's configuration directory is owned by root, we need to use this rather messy **sudo** and **tee** incantation. Keypairs need to be generated on both machines too. WireGuard needs to know the IP addresses and public keys of any peer that connects to it. If you're at home on your local network connecting to another local machine (a fairly pathological use case, but good for testing things), then use the LAN IP addresses. If you're dealing with a machine or VPS that's not on your LAN, you'll need to use your external IP (which you can get by entering **ip** into DuckDuckGo). WireGuard will create a new interface on both machines, each with their own IP addresses.

It's a bad idea to use anything other than the reserved private IPv4 ranges (for example, 192.168.*) for this, and it's an equally bad idea to use ones that conflict with your LAN. We've used the 10.* prefix (another private range), but if this is used on your LAN you should use something else.

We need to prepare WireGuard configurations at both ends, but don't worry – it looks worse than it is. On the remote, server machine edit (with sudo) /etc/wireguard/wg0.conf and populate it as follows. You'll want to copy and paste the appropriate keys.

The **[Interface]** section describes the local instance of WireGuard, so use its (not yet enabled) IP and the private key generated on it here. The **[Peer]** section describes anyone connecting to it, so use the public key from the local machine here. Using a **/32** mask in the IP address means only this peer is allowed to connect.

```
[Interface]
Address = 10.0.0.2/24
```

Browsing by proxy

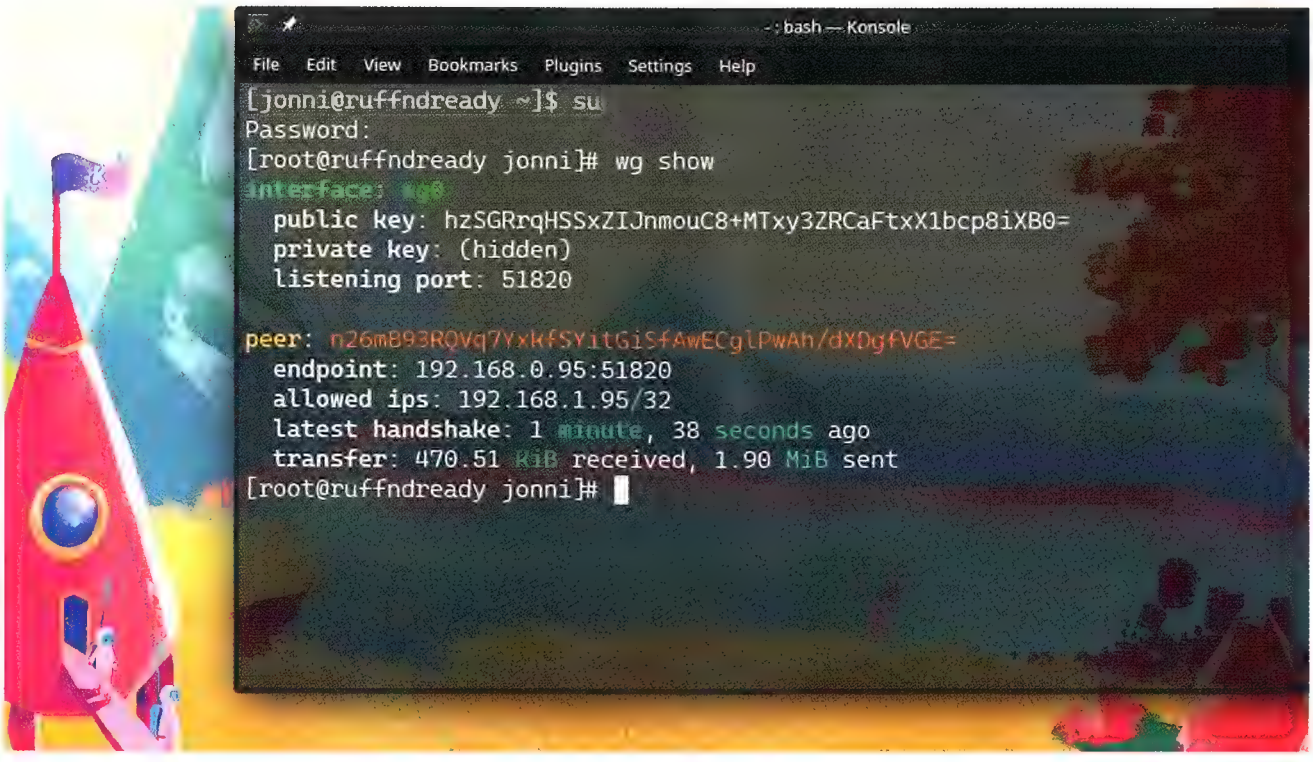
Another of OpenSSH's joyous treasures is that it can be used as a SOCKS proxy. This isn't the same as a VPN; it works at the session level rather than the transport level. But it does enable traffic to be tunneled over an encrypted connection and it does obfuscate the client IP address, which is certainly part of what a VPN does.

If you have a remote machine that you're already in the habit of SSHing into, then to achieve this SOCKS magic, instead of your usual incantation, add the following:

```
$ ssh user@myserver.com -D 3128
```

This will send traffic from port 3128 on the local machine to the proxy (you can use any available port number). Also, the -D option can be activated from the internal shell we mentioned earlier. Many applications support SOCKS proxies, but they need to be individually configured. To use your rough and ready proxy with Firefox, go to Settings > General > Network Settings and select Manual Proxy configuration. In the SOCKS Host box, enter localhost and enter 3128 in the Port box. Leave the radio button at the SOCKS v5 setting.

Hit OK and all your web traffic will be routed via your SSH server. Don't forget to reset the network settings when you disconnect the SSH connection, otherwise, the web will be replaced with a "proxy is refusing connections" error.



Here we can see a peer connected successfully. Adding more peers becomes exponentially more complex, though.

```
PrivateKey = ...=
ListenPort = 51820
[Peer]
PublicKey = ...=
AllowedIPs = 10.0.0.3/32
```

Do the same thing on the local machine, using a different 10.0 address and in the **[Interface]** section. In the **[Peer]** section you use the public key from the server. Replace the AllowedIPs setting to forward all traffic. And also add an endpoint so WireGuard knows to connect to your server's actual IP.

We've also added a keepalive setting, which the documentation says will help maintain NAT connections:

```
AllowedIPs = 0.0.0.0/0
Endpoint = 192.168.x.y:51820
PersistentKeepalive = 30
```

Almost there… you'll need to set

```
$ sudo sysctl net.ipv4.ip_forward=1
```

on both sides in order for traffic to be forwarded. Now start WireGuard on the server with

```
$ sudo systemctl start wg-quick@wg0
```

A side-effect of WireGuard is that it's easy for a misconfiguration to render the remote machine inaccessible if you use a conflicting IP in the **[Interface]** section. But most VPSes enable you to reboot, so it's not the end of the world if that happens. You can check everything's working on either machine by running

```
$ sudo systemctl status wg-quick@wg0
```

If there are no errors (including those perpetrated by yourself) you should be able to access the server using its imaginary 10.* IP address as well as its real one. However, you've probably noticed your local machine has lost its connection to the outside world. That's easy to fix with some firewall rules. We're assuming a new style interface name **enp1s0**, the command **ip a** will show you the correct name to use here. If you're running Ufw (on the server) you might need

```
$ sudo route allow in on wg0 out on enp1s0
```

to enable WireGuard traffic to ingress the network. You'll also need

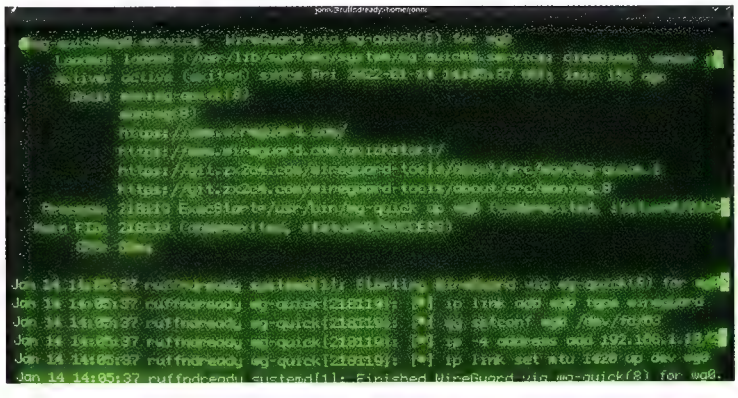
```
$ sudo iptables -t nat -I POSTROUTING -o enp1s0 -j MASQUERADE
```

so that traffic is NAT-ed accordingly. These commands (as well as the appropriate commands to deactivate things) can be added to the configuration file so that they are automated in the future. See the documentation for how to do this.

If you want a secure tunnel to your home connection or a VPS (virtual private server) when you're away, then we'll show you how.

We've demonstrated a fairly minimal example of WireGuard usage, but it's capable of much more. It supports IPv6, so if both machines have IPv6 connectivity then it's easy to use that as well or instead. It's also possible to add another layer of security in the form of a pre-shared key. As the name suggests this is shared between client and server. It can be generated with **wg genpsk** and then copied and pasted at both ends with a **PresharedKey =** directive.

Success! Our WireGuard configuration worked and it's made more exciting by Cool Retro Terminal.



Tor and other VPN alternatives

Tor has long been regarded as the gold standard for privacy and anonymity. Let's see how easy it is to go dark.

VPNs are advertised as being a boost for privacy, security, and anonymity. Those nouns may well apply in particular situations. But it's hard to call a VPN an anonymous service when you have to sign up with a very un-anonymous credit card. And it's hard to say for sure if they're private or secure if you're talking about a bunch of effectively centralised servers that no one can audit. Fortunately, there are alternatives, including one you've probably already heard of, Tor (formerly known as The Onion Router).

Similar to a VPN, Tor proxies traffic through encrypted tunnels, obfuscating users' IP addresses. It's different, though, because no one entity owns Tor. Anyone can run a Tor node and anyone can connect to it for free, without any sign-up process. Tor connections – or 'circuits'—are routed over at least three Tor nodes, with each hop unwrapping a layer of encryption (hence the old Onion name) to discover the next.

Similar to a VPN, Tor proxies traffic through encrypted tunnels, obfuscating users' IP addresses.

In this way, there's no correlation between the first and final nodes. Tor can be used in one of two ways: either as an intermediary to regular web service or to access Tor's hidden services, which have their own .onion domain names.

All manner of Tor users

You might have heard of Tor being used for organised crime, assassinations for hire, or any number of other bad things. Malfeasance certainly takes place there, but there are a number of legitimate services operating on the onions, too. The BBC News website, for example, is blocked in countries that would rather its citizens only tune in to state media. So, since 2019 the BBC has operated a Tor service at **www.bbcnewsv2vjtpsuy.onion**. Not exactly easy to remember, but a small price to pay to access a free press.

Tor service names are generally 16-character long random strings, but with a little effort, it's possible to personalize the first few letters of a string. Facebook (also blocked in a number of countries, but not necessarily deserving of a mention in a privacy feature) operates a Tor service at **https://facebookcorewwwi.onion**, for example.

It's worth mentioning that logging into Facebook and Google-type services does tend to identify you to some extent. Those ad-tracking cookies and Like and Share buttons follow you around whether you're using a VPN, Tor, or both. More on how to evade them over on the following page. For now, just make sure you're logged out of these services if you're doing anything other than using them on Tor. Again, we've got ahead of ourselves and haven't told you how to use Tor. Let's remedy that by visiting **www.torproject.org/download** and downloading the Tor Browser Bundle.

Extract it to your home folder (or wherever you like) and then run the bundled desktop file to add it to your Applications menu:

```
$ cd ~/tor-browser_en-US/
$ ./start-tor-browser.desktop --register-app
```

If you don't like having a static copy of the Tor browser in your home directory, then you can add the Debian repository.

How to do that is explained at **https://support.torproject.org/apt/tor-deb-repo**.

If you look on FlatHub (or if your application manager plugs into that) you can also avail yourself of the Tor Browser Launcher. This automates the process of downloading, configuring, and keeping the browser up to date.

That browser, as you'll see when you launch it, is a customised version of the Firefox ESR release. Hit the Connect button and see if you're able to connect to Tor. It will take a few seconds to establish relays and

Other ways to VPN

The other popular way to roll your own open-source VPN is with the OpenVPN protocol.

This is a much more complicated beast than WireGuard, but it's still easy enough to get started with a simple setup. This all relies on you having access to a remote server (if you want to use a VPN in the conventional way), and on you being confident that said server won't be compromised. Because if it was there's not much point in running a VPN on it.

We're not going to recommend any commercial service over any other, but we'd consider Mozilla a force for good in a world full of Metas and Alphabets and Yahoo! And it so happens you can support them by subscribing to their VPN service. It uses WireGuard (without you having to plan your subnets) and works with Linux. It might be a little pricier than other offerings but, hopefully, we've cast enough doubt on such offerings already. And no, Moz didn't pay us to write this.

Mozilla VPN

Mozilla VPN for Ubuntu Linux — a perfectly private pairing

As a fan of Ubuntu Linux, you already know the importance of privacy and security online. You probably also know about Mozilla and what we stand for — a private, open and free internet for all. It's time to bring the two together.

Mozilla needs to eat too, and it does care about its users. Perhaps this makes the company more deserving of your patronage.

circuits and such, but even if you're behind a firewall, it should still find a way. In some countries, publicly listed Tor relays are blocked, but there are options to remedy this. On the Tor Settings page, you can opt to use a bridge, which may come from a Tor Project listing or a trusted source. It's harder to block Tor bridges since a complete list of all of them doesn't and can't exist.

Once connected, try and view your favorite website and you'll see one of the main drawbacks of Tor. It's slow. Sometimes very slow. All bandwidth on Tor has effectively been donated, so it's considered bad form to (try to) use it for data-heavy activities such as streaming video. And if you use YouTube, since you have to sign in to watch videos, all you're really doing is telling Google that you're using Tor. And that will inform future adverts it chooses to sling your way.

Another odious technique the bad VPN sites use is to try to claim they're better than Tor because Tor is slow. Unfortunately, lots of VPNs, especially bad ones, have some sort of bandwidth limits, too.

If you want to find other Tor sites, a good starting point is The Hidden Wiki. This is a regular website (you can access it without Tor) full of links to popular Tor sites.

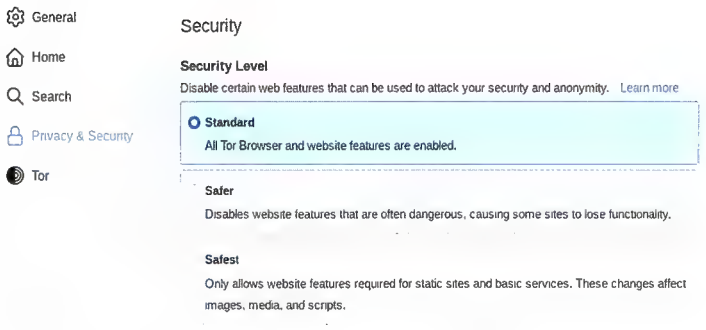
Exit, stage left

The bad VPNs vs Tor debate covers other areas too. It has been well-publicised that occasionally people operate malicious exit nodes. These are the last hop before traffic leaves the Tor network and is routed to the requested resource. If the user is accessing a Tor Service, i.e. a .onion address, then exit nodes are not used. Otherwise, they can see which domains are being accessed. Rather like a VPN provider can (in theory, if they accidentally left their no-logging option perhaps). Unlike the VPN case though, the exit node has no knowledge of the user's IP address. So again this argument is spurious. It's probably more accurate to say that bad Tor exits are better than bad VPNs. Although neither is that good, really.

If you want to find other Tor sites, a good starting point is The Hidden Wiki. This is a regular website (you can access it without Tor) full of links to popular Tor sites.

We would tell you the address, but since some of those sites aren't exactly for family viewing, we'll leave it for your favorite search engine. By default, the Tor Browser uses Permanent Private Browsing mode, which will delete all cookies and site data when the browser is closed. Like Firefox's regular Private windows, it also isolates different website cookies from one another, making it harder (if not outright impossible) for ad trackers to do their respective things.

Much is made of the fact that Tor was originally a Naval Research Project, and for a long time was funded by the US Department of State. There is still some government funding for Tor, but most contributions come from the private sector. A famous NSA presentation entitled 'Tor Stinks' was leaked by Edward Snowden in 2013. In it, our favourite three-letter intelligence agency decried their inability to decrypt Tor traffic but noted that targeted de-anonymisation was theoretically possible with some effort. So there's no secret Tor back door, but all kinds of attacks have been both theorized and attempted.


General
Home
Search
Privacy & Security
Tor
Security
Security Level
Disable certain web features that can be used to attack your security and anonymity. Learn more
Standard
All Tor Browser and website features are enabled.
Safer
Disables website features that are often dangerous, causing some sites to lose functionality.
Safest
Only allows website features required for static sites and basic services. These changes affect images, media, and scripts.

The Tor Browser includes NoScript and HTTPS Everywhere, and comes with three security settings depending on your levels of paranoia.

In 2014, researchers at Carnegie Mellon University carried out a successful de-anonymisation attack against Tor. Two years later it was confirmed that the USG had paid Carnegie SEI institute a considerable sum to research this. And that the aim of the exercise was to catch the operator of a darknet marketplace, which they duly did.

So Tor isn't impenetrable, and new and inventive ways will be found to attack it. But it's an open-source project and, as such, findings will be shared and, we'd hope, vulnerabilities fixed. There are malicious nodes operating (see **https://bit.ly/lxf286-kax17-vs-tor-users**), but also lots of smart people tracking them. Your VPN company might do the same, but as @SwiftOnSecurity once said, "I don't use a VPN because I'd rather Comcast aggregate my data than some dude wearing a dolphin onesie in his basement in Zurich."

Tor aims to protect you from all kinds of threats, but sufficiently determined adversaries and advertisers will always find a way.

BLOCK TRACKERS

Tor Browser isolates each website you visit so third-party trackers and ads can't follow you. Any cookies automatically clear when you're done browsing. So will your browsing history.

DEFEND AGAINST SURVEILLANCE

Tor Browser prevents someone watching your connection from knowing what websites you visit. All anyone monitoring your browsing habits can see is that you're using Tor.

Extra measures

See what VPNs don't and can't protect against, and bolster your privacy with a layered approach.

When you connect to a VPN, as well as proxying your traffic and setting the corresponding updates to your routing table, it may also provide you with different DNS settings. On paper, this was a reasonable idea. Traditional DNS requests (for example, where a website is resolved to 172.31.5.172) are transmitted in the clear, so even if the operator of a DNS server (typically one's ISP) doesn't know the web page a client is looking at, they at least are aware of the server it's on. This is known as DNS leakage. You may use another DNS server (such as Cloudflare's easy-to-remember 1.1.1.1 public offering), but again this is only viable if you trust that operator more than your ISP.

ISPs may also block certain domains at the DNS level, so for a time using someone else's DNS server was seen as a free and easy way around this by nefarious pirates, whose activities we do not condone. Many ISPs are aware of this, and many have taken the rather heavy-handed measure of performing DNS interception. Remember, we said DNS went over in the clear? Well, that makes it woefully easy for your ISP to just reroute those port 53 requests back to their DNS.

So VPNs now market themselves as providing DNS-leak resistant technology. Indeed, some offer an even more budget-friendly "DNS-only" option. The mechanics of this are straightforward: just tunnel DNS requests as well as (or instead of) other traffic. Again, this is just moving the problem of trusting the ISP upstream, to trusting the VPN operator.

While we may have no real problem with our government blocking torrent and streaming sites, or with ISPs voluntarily blocking child pornography sites, the same techniques are used by the brutal and anti-democratic regimes of the world to repress dissidents, activists and journalists. And that we cannot condone. One technical approach is to switch from classical DNS to DNS-over-HTTPS (DoH).

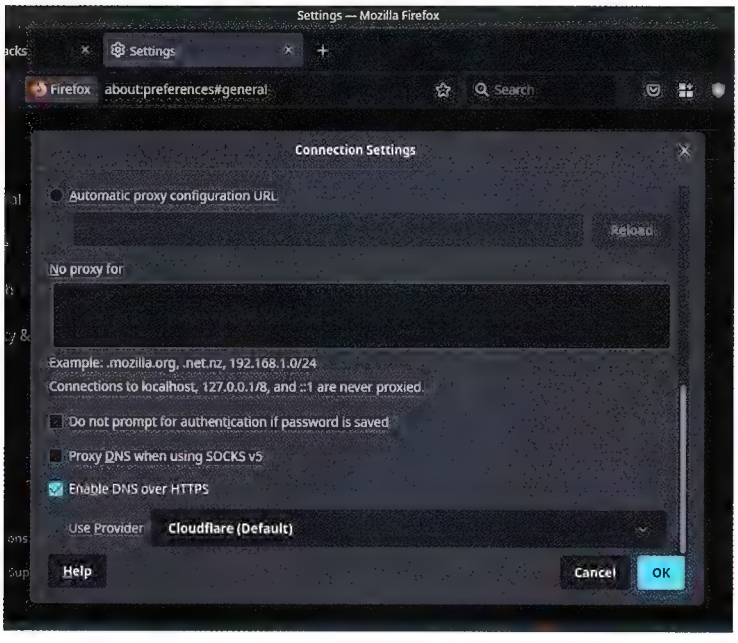
The same techniques are used by the brutal and anti-democratic regimes of the world to repress dissidents, activists and journalists. And that we cannot condone.

As the name suggests, this uses the same layer as secure web browsing to conduit DNS requests. Firefox already does this by default in the US for web browsing, but you can also set it up system-wide. That way, DNS requests are not only hidden amongst regular web traffic, they're also immune to interception (if you have faith in HTTPS, which you probably should).

Back in 2019, a largely insignificant organisation representing large ISPs had nominated Mozilla for an "Internet villain of the year" award based on its plans to roll out DoH by default. Allegedly because it aided and abetted piracy. In response, Firefox announced it would not be trialing DoH-by-default in some places, such as the UK. Indeed, it's still (as far as we could fathom) only the default in the US, but that hasn't stopped thousands of Firefox users turning the option on for themselves. Perhaps uptake has been aided by the friendly prompt that offers to "enable secure browsing" on first usage.

The DoH approach is no silver bullet though. There need to be entities operating DoH-enabled servers, and users need to be able to trust those entities. There are other efforts to secure DNS, most notably DNSSEC that ensures requests and responses aren't tampered with in transit. But that's complicated. What's unfortunately not complicated is running a rogue Wi-Fi hotspot in a coffee shop. From there you (well, hopefully not you, but someone bad) could return poisoned DNS responses to redirect users to cloned, password-harvesting versions of popular sites.

Or they might perform SSL-stripping attacks to try and get around encrypted web browsing (HTTPS), or they might even trick the user into installing a rogue Certificate Authority in their browser. That would be bad, and this is exactly the case where you might prefer to use a VPN. Though ideally one that you're running yourself.



You will find the option to enable DNS over HTTPS hidden away in Firefox's network settings.

Privacy and authenticity

We mentioned HTTPS earlier, which thanks to the efforts of Let's Encrypt has become ubiquitous across the web. This provides not only privacy so that no one observing the connection between you and the webserver can see beyond the first slash in the URL. But also authenticity, so you know, for example, the website you visit is indeed the same server as it was when the certificate was issued.

Some VPN providers twist the facts a little here. They would have you believe that this isn't enough and that the extra layer of encryption is a benefit. That's debatable since modern TLS 3 using Galois

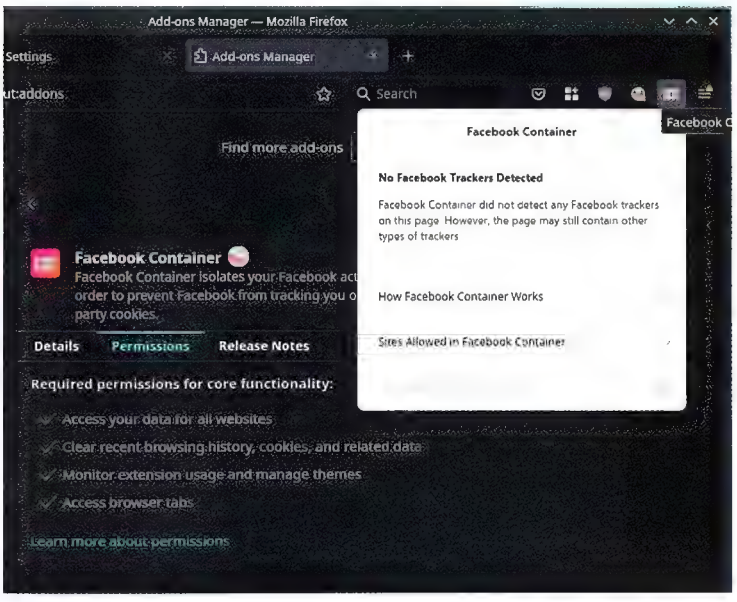
Fields and Elliptic curves is already difficult to crack.

Server operators can (if they keep and look at logs) see the IP address of every machine that sends their machine a request. And this is where VPNs are effective since these logs will only show the VPN server's address. That doesn't mean the originating IP address is impossible to figure out though. Browser-based video and voice communications are powered through the wonders of the WebRTC (Real-Time Communication) protocol.

Since most people are behind some sort of router or a firewall (and indeed perhaps a VPN too), it's generally not possible to establish a peer-to-peer connection through which to route all this traffic. So WebRTC uses intermediary STUN (Session Traversal Utilities for NAT) servers to exchange public and private IP addresses, and establish a connection. So with just a few lines of JavaScript, a web server operator can tell clients' originating IP addresses. Even if they're behind a VPN or other proxy.

Giving WebRTC the heave-ho

It's easy to work around this by disabling WebRTC in your browser settings, or even just disabling the address-exchanging part, but that hasn't stopped some unscrupulous operations from advertising their "WebRTC-leak" protection as some sort of value add. Some even have the audacity to claim a VPN will help stop Google and Facebook (or any other service that stores a login cookie) from tracking you around the web. What they don't say is that if you're signed into such an account, they will track you around the web. You're effectively telling them, "Hey it's me, I'm using this VPN's IP address now." To mitigate that risk, we can't recommend Mozilla's Firefox container add-on enough. This isolates browser cookies into different containers, so you can at least keep your casual browsing separate from your banking. There's a dedicated Facebook Container add-on if you want to evade Meta Corp's invasive tracking.


Add-ons Manager — Mozilla Firefox
Settings
Add-ons Manager
Search
Find more add-ons
Facebook Container
No Facebook Trackers Detected
Facebook Container did not detect any Facebook trackers on this page. However, the page may still contain other types of trackers
How Facebook Container Works
Sites Allowed in Facebook Container
Facebook Container
Details
Permissions
Release Notes
Required permissions for core functionality:
Access your data for all websites
Clear recent browsing history, cookies, and related data
Monitor extension usage and manage themes
Access browser tabs
Learn more about permissions

Fight Facebook with Firefox. And also fight all the other tracking cookie spaffers.

It's worth noting that attacks on VPN appliances (such as those provided by Fortinet and Pulse Secure) are on the rise. In April 2021, attackers were able to gain access to dozens of organisations in the defense industry.

A coordinated security response (and a US Department of Homeland Security advisory) was able to mitigate the damage in this case, but as we rely on VPNs to protect our workplace secrets, it's a matter of when, not if, there will be further attacks.

And there ends our study of the VPN threatscape. We don't mean to tar all VPN providers with the same brush. It's just that we hate to see honest surfers deceived by scaremongering and faux-security advice. And we're tired of all the sponsored product-placing they do on our favorite YouTube channels. If you trust your VPN provider, please let us know who they are and why you trust them. ■

Browser fingerprinting

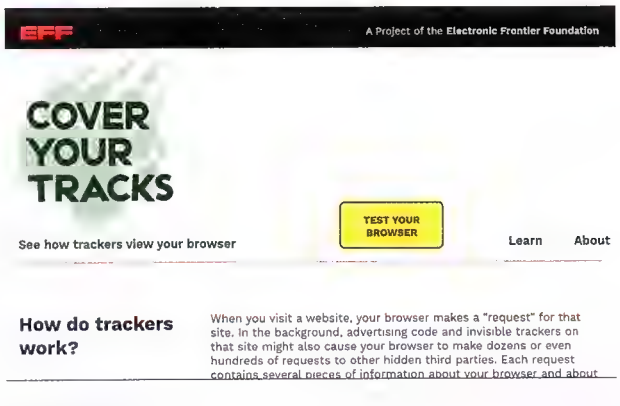
We've seen that there are other ways users can be identified besides their IP address.

One we haven't yet discussed in detail is browser fingerprinting. Even without recourse to the User Agent string, which can easily be falsified, everyone's browser, it turns out, behaves a little bit uniquely.

Specifically, different fonts (or JavaScript-constructed canvas elements) will render slightly differently on different systems with different resolutions. Likewise, everyone has their own WebGL attributes and their own set of headers that any old web page can happily request.

All of these variables can be measured, and there's sufficient variety that by studying a handful of metrics, website operators can uniquely fingerprint your browser.

The Tor Browser takes steps to block browser fingerprinting, with the goal that all Tor Browser users appear more or less identical. You can also use the EFF's Privacy Badger browser plugin, which blocks domains known to perform digital fingerprinting. The popular NoScript add-on can help too, but this interferes with a lot of sites' functionality. Browser add-ons themselves can also become part of the fingerprinting process so, in practice, it's difficult to avoid this identity leakage.


EFF
A Project of the Electronic Frontier Foundation
COVER YOUR TRACKS
See how trackers view your browser
TEST YOUR BROWSER
Learn
About
How do trackers work?
When you visit a website, your browser makes a "request" for that site. In the background, advertising code and invisible trackers on that site might also cause your browser to make dozens or even hundreds of requests to other hidden third parties. Each request contains several pieces of information about your browser and about

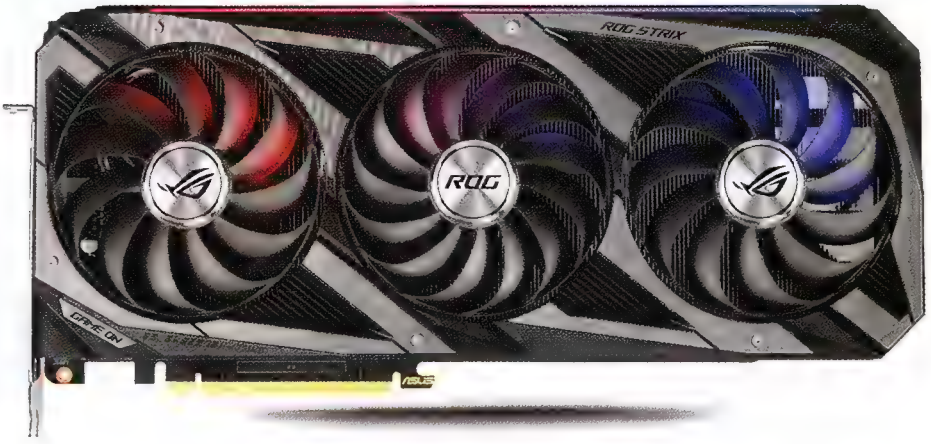
Check out the EFF's Cover Your Tracks site to see how unique your browser is.

PC BUILDER

WHAT'S HAPPENING IN THE PC WORLD

System news

Mark Williams has been waiting a long time for something to happen, and Nvidia obliged.



It has finally happened; the graphics card pricing bubble has popped! Prices have been crazy for over a year now with all cards from both brands selling for well above their recommended retail price (RRP).

But during March something happened, and overnight the RTX 3080 dropped drastically in price, first by thirty percent and now by as much as forty percent, which equates to a $1,000 reduction!

From there all the other Nvidia cards started to fall as well. Richard from Aftershock PC shed some light on the matter for us to give some explanation of what happened: "Nvidia sales slumped dramatically through the first couple of months this year (which was reflected in our own sales and from what I hear, those across the tech market). In order to pick sales up, Nvidia came to some form of agreement with Asus to drop prices back down to around the original RRP.

Once Asus did this, other GPU vendors had no choice but to follow suit and drop theirs to at or below the Asus pricing. Had Nvidia chosen another brand to do this price drop it may not have been as effective for shifting the entire market, as Asus is still seen by our customers as the market leader, the most premium and highest-end, so Asus was the logical choice."

Richard went on to explain how wide the impact was across the product stacks: "This was across the board with less impact on the lower-end GPUs and a huge impact on the high-end ones. So far, from what I have seen, AMD has been struggling to react and is only just now trying to get their pricing back in line. There has been plenty of pressure from vendors to try and take some AMD cards in all sorts of deals as they are finding them very difficult to move."

Since talking to Richard prices have continued to fall and we're happy to say that the lower end has seen just as much of a drop as the high end. For example, the RTX 3060 Ti has dropped from $1,200 to $800 currently (33 percent down). We've also seen that AMD card prices have now similarly also fallen off a cliff with the top end RX 6900 XT going from $2,500 down to $1,850 – a cool 26 percent reduction. At the lower end the RX 6600 XT has fallen from around $900 to just $650 now.

When asking Richard if he thought if prices would continue to fall, he said: "I don't see prices falling further, as I think there are a lot of other factors at play that are going to creep in over the next little while, the major one being the severe lockdowns in China causing factories and shipping out of China to come to a standstill. In addition, with Ethereum's gradual shift to proof of stake taking place in stages over the next several months, there's expected to be a decreasing incentive for Ethereum miners to invest in GPUs through that period, so it's reasonable to expect that will help send prices downwards through this year as that takes place. The crypto prices are also increasing quite significantly, which is also putting strain back on GPU stock."

There's expected to be a decreasing incentive for Ethereum miners to invest in GPUs through that period, so it's reasonable to expect that will help send prices downwards through this year as that takes place.

MARK WILLIAMS
Mark is an IT professional with a strong interest in voiding warranties.

With prices now back to normal we can hope for a return to form in the coming months with a gradual easing of prices as Nvidia's RTX 4000 series launch looms, as well as AMD's upcoming RX 7000 series. And with Intel set to enter the discrete graphics card market for the first time in the next few months it'll further pressure AMD and Nvidia into keeping prices down to compete.

SHOP TALK

As a result of the market price corrections, have you taken a hit on profit margins for your current card stock? Have customers taken advantage of return policies to get refunds?

Richard, AftershockPC:
"We have taken a massive hit and have had to sell pretty much all the GPU stock we had on hand over the last couple of weeks at well below what we bought it for, which has significantly reduced margins (and often made them negative). Fortunately, we are through that phase now and are now buying GPUs at the new norm of wholesale pricing, however, margins are now much slimmer than they were.

We did have quite a few customers who bought just prior to the drop reach out to us and in most cases we provided them with free upgrades (out of our own pocket) to make up the price drop difference and keep them happy."

Market snapshot

A sampling of PC systems available this month

$1,899 – tinyurl.com/APC507TT

THERMALTAKE COMPACT CORE

This system isn't the smallest form factor you can find, coming in at 23 litres, but it is big enough to house many full-sized components. All the components here are low end or old enough to make the asking price a bit much to swallow. The Ryzen 3600 is a stalwart in AMD's line-up, however its time has passed, with the Ryzen 5600 beating it in both price and performance. The motherboard supports it too, so perhaps Thermaltake is trying to get rid of old stock. The graphics card is within spitting distance of the new RTX 3050's performance, just without support for RTX features. The RAM is well matched, and the SSD and PSU capacities are appropriate for this class of system.
An OK system for those where space is at a premium, but there are better options out there.

CPU: AMD Ryzen 5 3600; **Cooler:** Thermaltake TH240 ARGB AIO Liquid Cooler; **Motherboard:** Asus TUF A520M-Plus WIFI; **Graphics:** Nvidia Geforce GTX 1660 Super; **Memory:** Thermaltake ToughRAM Z-One RGB 3200MHz 16GB; **Storage:** 500GB M.2 NVMe; **Power Supply:** Thermaltake SFX 550W; **Case:** Core G3 Gaming Slim.

$1,899 – tinyurl.com/APC507MWV

MWAVE RESPAWN NINJA ESPORTS ALPHA

If size is of no concern to you then this system, for the same price as the Thermaltake Compact Core, is a much better value proposition. Touting the 11400F CPU, which is the outgoing value CPU champion, it offers ample performance for the paired RX 6600 XT which affords RTX 3060-beating levels of performance – meaning high refresh rate 1080P or 1440P gaming capability. Although Intel 11th Gen CPUs don't benefit from high-speed memory as much as AMD chips do, this is curiously paired with some quite fast 3,600MHz RAM.

The sizeable 1TB SSD is also welcome here, as is the 750W PSU, with both being bigger in capacity than the Thermaltake offering. A great option for those looking to game without breaking the bank.

CPU: Intel Core i5 11400F; **Cooler:** Be Quiet! Pure Rock 2; **Motherboard:** Asus TUF Gaming B560M-Plus; **Graphics:** Asus Radeon RX 6600 XT Dual 8GB; **Memory:** T-Force Delta RGB 16GB DDR4 3600MHz; **Storage:** Crucial P2 1TB NVMe M.2 SSD; **Power Supply:** Asus TUF Gaming 750W; **Case:** Be Quiet! Pure Base 500.

$2,650 – tinyurl.com/APC507TI

TI COMPUTERS TI 12TH GEN TUF GAMING

This system is sweet in its own right, but you have to be able to use it correctly to get the most out of it.

You see, this gaming PC is about on par, if not slightly less powerful than this month's cheaper Mwave PC. The trick with this system is that it has a vastly more powerful CPU in the 12700F. With eight performance cores and four efficiency cores giving a total of 20 threads, this system is much more suited to those in need of more CPU horsepower in their system. Perhaps you're doing some CAD work, rendering, or AI training? Whatever the case, this system is a bit of a waste of money if all you intend to do is game.

A beefy cooler keeps the hot star of the show cool and with 32GB of RAM and 1TB of storage, you'll chew through your datasets with ease.

CPU: Intel Core i7 12700F; **Cooler:** Noctua NH-D15; **Motherboard:** Asus Prime Z690-P WIFI; **Graphics:** Nvidia RTX 3060 12GB; **Memory:** 32G DDR4 3200MHz RGB; **Storage:** 1TB NVMe M.2 SSD; **Power Supply:** Antec 850W; **Case:** Antec NX800.

$2,799 – tinyurl.com/APC507PLE

PLE COMPUTERS COBALT

Pushing into the mid-tier class of PCs, this system's Ryzen 5600X and RX 6700 XT pairing is a very powerful combination for the price. With the GPU offering RTX 3060 Ti-beating performance – 1440P at high frame rates should be easy, and if 1080P at 240Hz+ is your jam for competitive game titles, the CPU will keep up easily.

The B550 Tomahawk is one of the best of this generation, a great base for the rest of the system. The RAM is a letdown at only 3,000MHz, lower than the stock 3200MHz the CPU is rated for. Possibly a cost reduction choice. As is the 500GB SSD + 1TB HDD combo instead of a single 1TB SSD. As a whole though, this is a good choice for those serious enough about gaming wanting to spend a bit extra for the performance benefits.

CPU: AMD Ryzen 5 5600X; **Cooler:** OEM; **Motherboard:** MSI MAG B550 Tomahawk; **Graphics:** XFX Radeon RX 6700 XT Speedster QICK 319 Black 12GB GDDR6; **Memory:** GelL 16GB Kit DDR4 Orion C16 3000MHz; **Storage:** Samsung 980 500GB NVMe M.2 SSD, WD Blue 1TB HDD; **Power Supply:** EVGA GD Series 700W; **Case:** Deepcool Matrexx 50.

BLUEPRINTS

VALUE- AND PERFORMANCE-DRIVEN HYPOTHETICAL BUILDS

PC BUILDER

Budget

A perfect balance between price and peformance.

We're finally bringing the budget AMD build up to the current generation, replacing the Ryzen 5 3600 with the 5600X – at a price increase of just $30. This should net us around 10-20 percent better performance, depending on the workload. Since this is the 'budget' machine, we're not upgrading to a more costly X570 motherboard, but sticking with the B550 chipset in Gigabyte's Aorus Elite AM4 motherboard. This move also nets a nice $51 saving over the MSI MPG B550 Gaming Plus AM4 used previously. Bear in mind you may need a 2000- or 3000-series Ryzen CPU to update the board's BIOS if you buy a used or refurbished board.

We've adjusted the GPU used in the AMD system from a Radeon RX 6700 XT down to the 6600 XT (Sapphire's Nitro+ model) as it's a more appropriate card for a system targeting 1080p in games. Here we realise a hefty $371 saving! It's joined by new memory from Kingston, the Fury Renegade 2x 8GB kit at 3600MHz. The same kit is also found in the Intel budget build.

We're going budget on our SSDs for both systems too, cutting down from 512GB to 500GB (barely noticeable for most users) but keeping PCIe 4.0 for speedy file transfers. The AMD system gets the new MSI Spatium M450, priced at a reasonable $120, while its Intel counterpart is using the T-Force Cardea Graphene Z44L from Team Group. Both machines are keeping the 4TB WD Blue for HDD secondary storage, which is holding steady at $120. If you're assembling one of these machines but don't think you'll need that much storage, consider nixing the hard drive and upgrading to a 1TB SSD instead.

Budget GPU prices appear to be stabilising. As well as the 6600 XT in the AMD build, the Intel budget rig has a new graphics card: the Dual GeForce RTX 3050 from Asus, a solid wallet-friendly GPU costing $550, the lowest it's been in months. Don't forget our Intel system is currently using the Core i5-12400F as its CPU, which offers a lower price tag in exchange for a lack of integrated graphics, so a dedicated GPU is a must.

AMD INGREDIENTS

PART		PRICE
CASE	Corsair 4000D Airflow	$125
PSU	550W Corsair CV550 80+ Bronze	$75
M/BOARD	Gigabyte B550 Aorus Elite AM4 **NEW**	$149
CPU	AMD Ryzen 5 5600X **NEW**	$339
GPU	Sapphire Nitro+ Radeon RX 6600 XT 8GB **NEW**	$729
RAM	16GB (2 x 8GB) Kingston FURY Renegade CL16 @ 3600MHz **NEW**	$125
SSD	500GB MSI Spatium M450 PCIe 4.0 M.2 SSD **NEW**	$119
HDD	4TB WD Blue 5400 HDD	$120
OS	Windows 10 Home 64-bit OEM (Win 11 Compatible)	$60
PRICE		$1,841

INTEL INGREDIENTS

PART		PRICE
CASE	Corsair 4000D Airflow	$125
PSU	550W Corsair CV550 80+ Bronze	$75
M/BOARD	Asrock B660 Pro RS	$229
CPU	Intel Core i5-12400F	$269
GPU	Asus Dual GeForce RTX 3050 8GB **NEW**	$549
RAM	16GB (2 x 8GB) Kingston FURY Renegade CL16 @ 3600MHz **NEW**	$125
SSD	500GB Team T-Force Cardea Graphene Z44L PCIe 4.0 M.2 SSD **NEW**	$129
HDD	4TB WD Blue 5400 HDD	$120
OS	Windows 10 Home 64-bit OEM (Win 11 Compatible)	$60
PRICE		$1,681

PC BUILDER

Mid-range

A game-ready machine that can also handle demanding work.

Power supplies seem to be affordable this month, with last issue's EVGA SuperNOVA 750 GA still great value and Nzxt's C750 costing a sensible $134; both 80+ Gold rated for efficiency. Storage is also reasonable, with the top-notch 500GB Samsung 980 Pro a good buy at $150 and the Corsair Force MP600 (from last issue's Intel system) down to $145. Low prices prompted us to leave our drives alone, but the same can't be said for the AMD mid-range CPU. With our budget AMD PC upgrading to the Ryzen 5 5600X, we're upgrading to the Ryzen 7 5800X, which offers eight cores and 16 threads to the 5600X's six and 12. Multi-core speed is a lot faster, especially when overclocked. If you're assembling a 1440p rig for games, consider sticking with the 5600X.

With a jump from Ryzen 5 to Ryzen 7, we opted to make a similar leap in the Intel machine. For a smaller price rise, we upgraded to the Core i7-12700F, aping the budget machine by choosing an F-series Intel CPU without integrated graphics. Processor performance is near-identical to the standard i7-12700, with eight hyperthreaded performance cores and four efficiency cores allowing for a total of 20 threads. Although the 5800X offers a higher base clock, overall performance from the 12700F is superior. The only downside is that Z690 motherboards are more pricey than their X570 equivalents.

While lower-end GPUs might be getting more affordable, powerful cards are still pretty expensive. The AMD machine keeps its MSI Gaming RX 6800 XT and its whopping 16GB of VRAM, while the Intel build has swapped over to the three-fan Asus TUF Gaming RTX 3070, which is one of the most affordable 3070 cards available at the time of writing. You'll also see that both systems have a new CPU cooler, the excellent H100i RGB Pro XT from Corsair, which is a steal at $169 and is compatible with both current-gen CPU sockets. Lastly, both systems are now benefiting from new memory in the form of the sleek Corsair Vengeance RGB RT.

AMD INGREDIENTS

PART		PRICE
CASE	Lian Li PC-O11-Dynamic	$209
PSU	750W Nzxt C750 80+ Gold **NEW**	$134
M/BOARD	Asrock X570 Phantom Gaming 4	$199
CPU	AMD Ryzen 7 5800X **NEW**	$499
COOLER	Corsair iCue H100i RGB Pro XT 240mm **NEW**	$169
GPU	MSI Gaming Radeon RX 6800 XT 16 GB	$1,499
RAM	16GB (2x 8GB) Corsair Vengeance RGB RT CL16 @ 3600MHz **NEW**	$159
SSD	500GB Samsung 980 Pro NVME M.2 PCIe 4.0 SSD	$149
HDD	4TB WD Blue 5400 HDD	$120
OS	Windows 10 Home 64-bit OEM (Win 11 Compatible)	$60
PRICE		$3,197

INTEL INGREDIENTS

PART		PRICE
CASE	Lian Li PC-O11-Dynamic	$209
PSU	750W EVGA SuperNOVA 750 GA 80+ Gold	$149
M/BOARD	Asus Prime Z690-P LGA 1700	$299
CPU	Intel Core i7-12700F **NEW**	$479
COOLER	Corsair iCue H100i RGB Pro XT 240mm **NEW**	$169
GPU	Asus TUF Gaming GeForce RTX 3070 8GB **NEW**	$1,199
RAM	16GB (2x 8GB) Corsair Vengeance RGB RT CL16 @ 3600MHz **NEW**	$159
SSD	500GB Corsair Force MP600 M.2 PCIe 4.0	$145
HDD	4TB WD Blue 5400 HDD	$120
OS	Windows 10 Home 64-bit OEM (Win 11 Compatible)	$60
PRICE		$2,988

PC BUILDER

Turbo

The maximum PC.

It's time to get serious and kick things up to the max for our turbo builds. While the Core i9-12900K is still a beast, there was room for improvement in the AMD build, so we've taken a step up from the Ryzen 9 5900X to the top-tier 5950X. Intel's chip is faster overall, but it's also a more recent release, so we'll have to wait for AMD's 6000 series of CPUs to see if Team Red can claw back ground at the high end. Meanwhile, the AMD system already had a flagship GPU (the RX 6900 XT, in this case, Asrock's Phantom Gaming D version), but the Intel system was sitting slightly below its maximum graphical potential with an RTX 3080 Ti. So, we've upgraded to an RTX 3090, specifically EVGA's FTW3 Ultra Gaming model, with a big juicy RGB strip and 24GB of VRAM. Of course, we'll probably be updating this again soon, since Nvidia announced the faster 3090 Ti at CES.

We decided to bump up the wattage of our Intel build a little, given that the GPU and CPU alone are capable of drawing more than 550W combined. To ensure a good amount of overclocking headroom, we've upgraded from a 750W capacity PSU to the Corsair RM850. The lower TDP of the Ryzen chip means we're sticking with Be Quiet!'s 750W Pure Power 11 FM in the AMD rig.

A price drop on the WiFi-equipped version of Gigabyte's X570 Aorus Elite motherboard saw us make the switch from its WiFi-less sibling, while we stuck with the MSI board in our Intel turbo system. Elsewhere, the Gigabyte SSD in the Intel machine was out of stock, so we swapped over to the 1TB FireCuda 530 from Seagate. The Intel build also gets a new AIO cooler, the Asus ROG Strix LC II 360 ARGB, which matches the three fans of the AMD build's cooler, though is much more expensive.

We've swapped out the Sabrent SSD in the AMD build for the same Seagate FireCuda that's in the Intel build, mainly because the Sabrent is often difficult to find and buy.

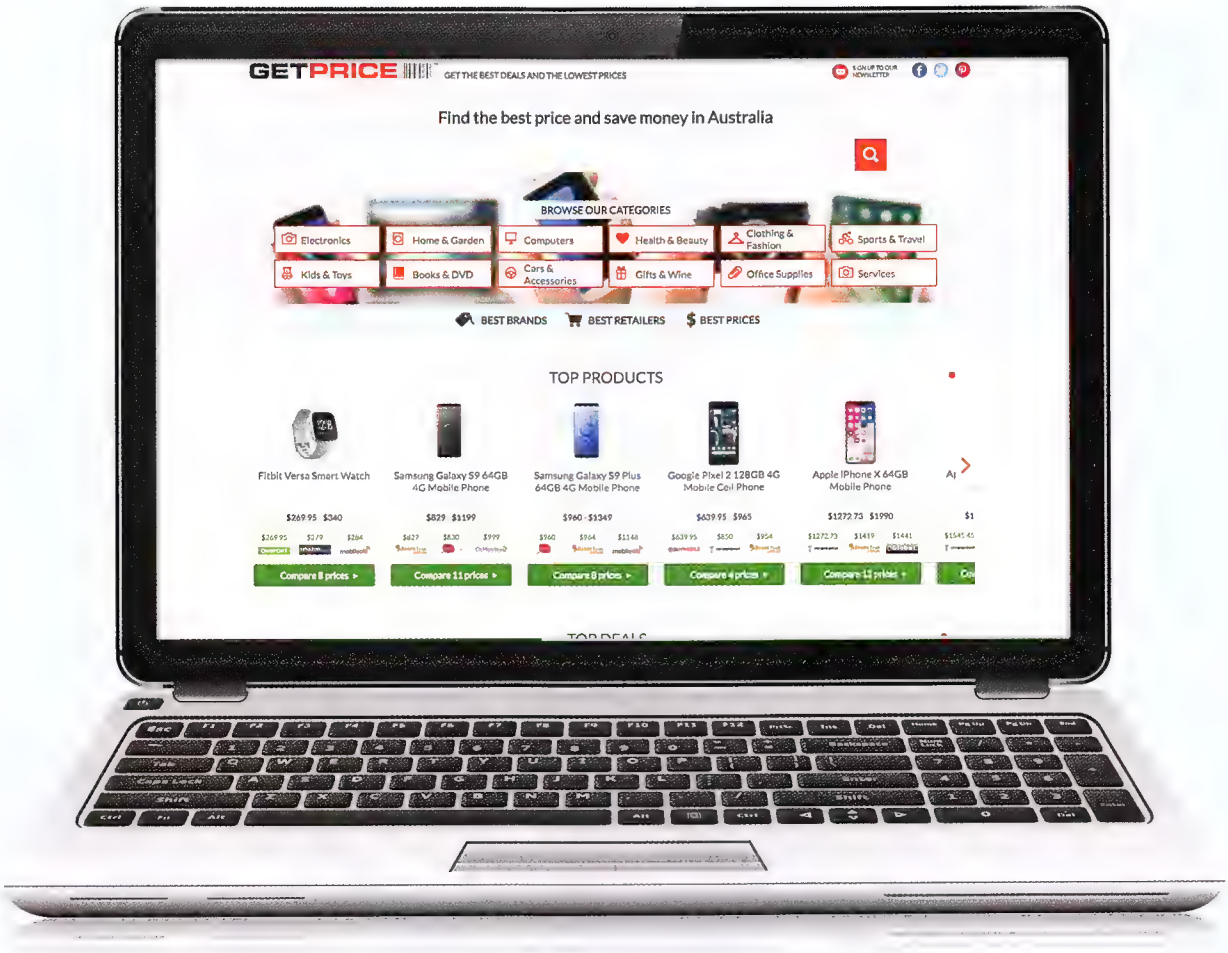
The Intel build's AIO cooler, graphics card and DDR5 memory are more costly than the items we've put in the AMD box, creating an unusually large price disparity between the two builds. You could certainly use the AMD build's AIO and graphics card in the Intel box and bring the price right down. ■

AMD INGREDIENTS

PART		PRICE
CASE	Phanteks Enthoo Pro 2 Tempered Glass	$220
PSU	750W Be Quiet! Pure Power 11 FM 80+ Gold	$169
M/BOARD	Gigabyte X570 Aorus Elite WiFi **NEW**	$195
CPU	AMD Ryzen 9 5950X **NEW**	$869
COOLER	MSI MAG CoreLiquid 360R ARGB	$169
GPU	Asrock Radeon RX 6900 XT Phantom Gaming D 16GB	$2,149
RAM	32GB (2x 16GB) G.Skill Ripjaws V 32GB @ 4000MHz	$309
SSD	1TB Seagate FireCuda 530 M.2 PCIe 4.0 SSD **NEW**	$379
HDD	6TB WD Blue 5400 HDD	$195
OS	Windows 10 Home 64-bit OEM (Win 11 Compatible)	$60
PRICE		$4,714

INTEL INGREDIENTS

PART		PRICE
CASE	Phanteks Enthoo Pro 2 Tempered Glass	$220
PSU	850W Corsair RM850 80+ Gold **NEW**	$189
M/BOARD	MSI PRO Z690-A WiFi LGA1700	$329
CPU	Intel Core i9-12900K	$799
COOLER	Asus ROG Strix LC II 360 ARGB **NEW**	$349
GPU	EVGA GeForce RTX 3090 FTW3 Ultra Gaming 24GB **NEW**	$2,899
RAM	32GB (2x 16GB) Kingston FURY Beast DDR5 @ 5200MHz	$409
SSD	1TB Seagate FireCuda 530 M.2 PCIe 4.0 SSD **NEW**	$379
HDD	6TB WD Blue 5400 HDD	$195
OS	Windows 10 Home 64-bit OEM (Win 11 Compatible)	$60
PRICE		$5,828



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Quick Tips

The problem solvers

The *APC* team field problems across the spectrum of devices and software. Learn a new trick or fix you can use.

PC TV?

I have a TV hanging on the wall of my kitchen. It's nice, but it's not a computer. How can I get a microcomputer glued to its back panel with Bluetooth connections to a keyboard and mouse? I was thinking about stripping down an old laptop, attaching its working parts to the back of the TV, and using a wireless mouse and keyboard with it. It would need Wi-Fi, as well as Windows.
Gary Dent

***APC* responds:** The problem with stripping down a laptop is that its parts have been custom designed for that specific model and manufacturer, and the case designed around it.

While some laptops are easier to disassemble than others – Google your manufacturer and model with the words 'service manual' to find a detailed manual – there's still the question of what to do with the bespoke components inside. You won't, for example, be able to rehouse them in a standard or mini form factor case; in fact, you'd almost certainly need to build your own custom case designed for the components you've plundered.

I have a TV hanging on the wall of my kitchen. It's nice, but it's not a computer. How can I get a microcomputer glued to its back panel with Bluetooth connections to a keyboard and mouse?

Long story short, the costs, expertise, and time involved in such a project – with no guarantee of success at the end of it – are prohibitive in ours eyes. Depending on the size of the TV and the strength of its mount to the wall, you could consider simply fixing the laptop behind it with the lid permanently closed.

If you go down this route, you'll need to disable any power controls such as sleep or shutdown associated with closing the lid, plus configure it to ignore the built-in display in favour of the TV. Then pair an external wireless keyboard and mouse to it via Bluetooth and hey presto: a clunky, but working PC behind the TV.

Perhaps a better approach is to consider investing in a mini-PC – one designed to be affixed to the back of a display using its VESA mounts. These are surprisingly affordable, if low-powered. The Intel NUC 10 series is one to look out for – these barebones systems require you to add your own RAM, storage, and copy of Windows, and come in a staggering number of configurations to suit every pocket and purpose.

Better still, NUC 10s use laptop-friendly SO-DIMMs, so there's a possibility you could marry up a system to your old laptop to enable you to salvage the RAM and storage from your old system. For example, if your laptop supports the older DDR3L RAM, then an Intel NUC BOXD3401 system is a good budget choice, sporting a 4th generation Core i3 processor, but it's a bit bulky for sitting behind a wall-mounted TV and there's no built-in Wi-Fi or Bluetooth. Search for 'Intel NUC BOXD34010WYKH'.

The newer Intel NUC 10 BXNUC10i3FNKN1 costs just $449, supports SO-DIMM DDR4 2666 RAM, and has both Bluetooth and Wi-Fi built-in. It's also powered by a newer 10th generation Core i3 processor, and more powerful i5 and i7 models are available for a premium. This also has a much slimmer case, making it more suitable for placing behind a wall-mounted TV.

Win11 SSD slowdown

First of all, thank you for your awesome magazine and talented authors who write informative articles. I was reading about SSD slowdowns related to Win11 and Samsung SSDs in a past issue.

I just conducted a performance benchmark of my Samsung 970 EVO Plus and have noticed that it is slightly slower than before I updated to Win11. I'm thinking that this might be more of a firmware issue rather than an issue with Win11. What do you think?
Scott Cortese

***APC* responds:** It's almost certainly an issue with Windows rather than Samsung, Scott. First, the performance issue affects a wider range of SSD and NVME drives than just Samsung. Second, it's only apparent on system drives, so if you're using SSD and NVME drives for pure data storage, performance remains strong.

And crucially, Microsoft has already issued one update that acknowledges the problem and has – successfully for some – attempted to fix it, namely KB5007262. That update claimed to address an issue that affected the performance of any hard disk in Windows 11 through performing unnecessary actions when the NTFS USN journal was enabled, which is always the case on the C drive.

That said, it pays to check for firmware updates in case these can help mitigate the issue. A recent firmware update for the 980 has reportedly delivered much better random read/write speeds, but no such firmware update has been issued for the Samsung 970 EVO line. That said, if you've not yet done so, installing Samsung's NVME drivers in place of the standard Microsoft ones should yield performance benefits too – *APC* witnessed small, but noticeable improvements in both random read and write times with his 970 drive after installing Samsung's drivers.

External optical enclosure

Would you have suggestions or recommendations for those of us who want to do a new build but aren't ready to go without our optical drives?
James

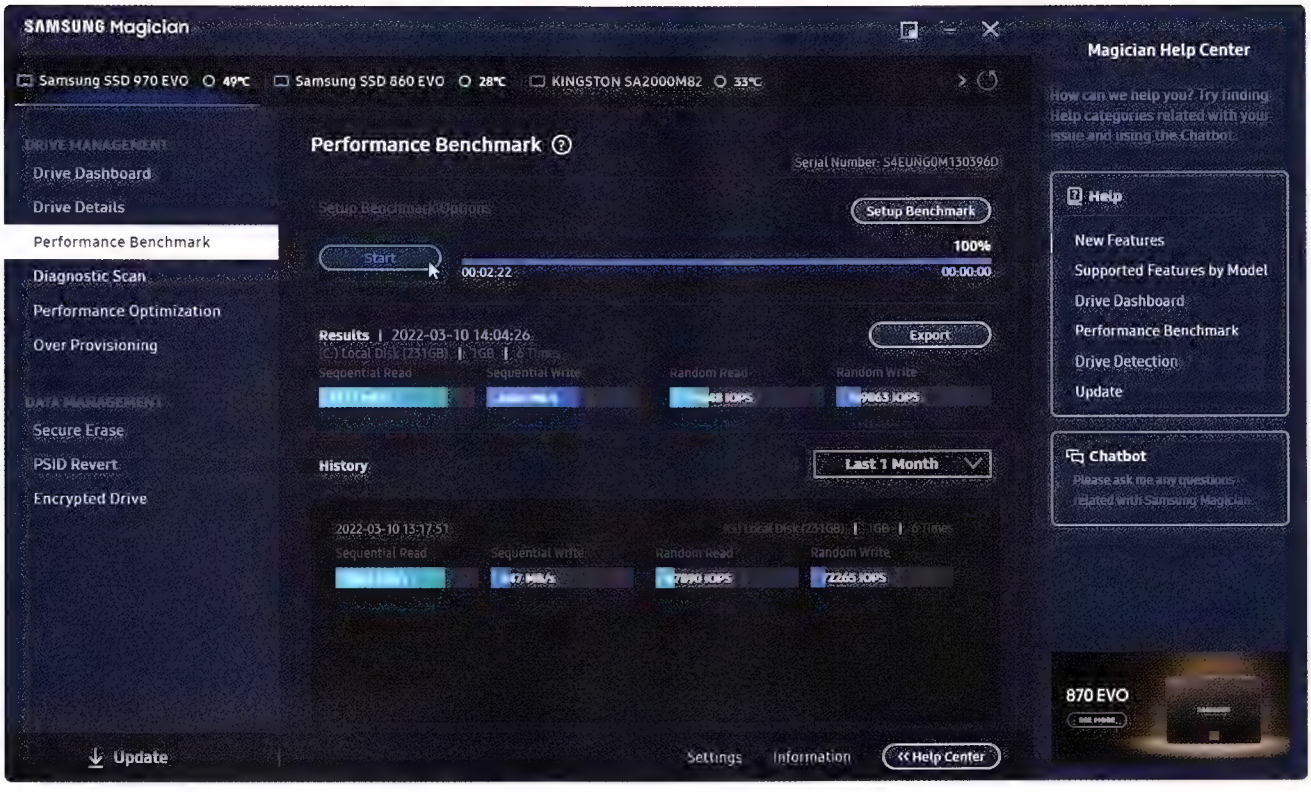
***APC* responds:** Optical drive enclosures are becoming almost as rare as optical drives, particularly when it comes to full-height 5.25-inch optical drives. In fact, your options are limited to just one that we could find: the OWC Mercury Pro 5.25-inch Optical Drive External Enclosure, which will currently set you back $137 from **www.amazon.com.au**. For just $3 more you can purchase an external Blu-ray burner – $140 buys you a MthsTec USB 3.0 and Type-C model, also from Amazon.

It's a lot less expensive if you're looking to repurpose a laptop optical drive – StarTech offers a USB 3.0 model that supports the slimline SATA models found in many laptops for just $38.

KeePass follow-up

I read with interest your response in the February 2022 issue of the mag to an inquiry about KeePass. I was a little surprised that you stated that "KeePass development has stalled of late." I don't believe this to be true. Their website at **www.keepass.info** shows regular updates, the latest being January 9, 2022 (as I write). That version is v2.50.

I have been using KeePass for many, many years ever since reading of its recommendation in *APC*, and it has served me well. I was not aware of



Native SSD drivers offer better performance.

KeePassXC mentioned in your reply, but it appears to be a fork of a fork of KeePass. All good, but perhaps you could tell us about the differences between the original KeePass and the two forks along with their pros and cons? I have noticed that KeePass does not appear in your recent reviews of password managers for some reason.
Dennis Younker

***APC* responds:** Apologies, Dennis, we didn't make it clear he was primarily referring to the KeePass 1.x fork that Steve was using. You're right, of course, that KeePass 2.x continues to be updated two to three times a year. The major reasons for the recommendation to Steve that he switch to KeePassXC are that it sports a more modern interface, runs natively on Linux. macOS and Windows, and offers better integration with web browsers through plugins, all of which addressed Steve's concerns.

The reason why KeePass hasn't featured in recent password manager roundups and reviews is related to these shortcomings – it's a capable password manager, but lacks the cross-platform support found in other tools that enable you to carry your passwords securely on your phone or sync them to other computers in your household, never mind simplify the logging into websites or filling in online forms.

While there are third-party solutions based on KeePass to extend its support to other platforms and devices, it's not as elegant or unified a solution in our eyes as the likes of Buttercup (**https://buttercup.pw/**) or Bitwarden (**https://bitwarden.com**), which can be run on your own server for maximum security.

Cheap Windows 10

I am rebuilding an old computer from information in your ' PC Builder' section replacing a 12-year-old mobo and CPU and moving from 32-bit OS to 64-bit. That section shows the price for the Window OS as $60, but I cannot find where to purchase it at that price.

I recall seeing this explained in a previous issue, but didn't keep my old copies. Could you refresh my memory of where to purchase the Windows 10 Home 64-bit OEM OS?
Charles Zimmerman

***APC* responds:** Google 'Windows 10 OEM' and you'll see lots of online stores offering OEM licenses at deep discounts, many under $50, and you may even see one or two below $30. In many cases, these licenses should work fine, but you're taking a risk that they may not.

Note that you don't need to purchase a new license when switching from 32-bit to 64-bit, only when moving between Home and Pro versions of Windows 10. This means if you'd successfully installed Windows 10 on your old hardware, you'll potentially be able to transfer the license from it to your newly rebuilt PC.

If your old PC is running, go to 'Settings > Update & Security > Activation' to verify its status – make sure it's both digital and linked to your Microsoft Account (click 'Add an account' if this isn't the case). Alternatively, log on to your Microsoft Account at **https://account.microsoft.com** and check the Devices list. If your old PC is here, you'll be able to transfer the license.

Once you've confirmed the existence of an existing digital license for transfer, perform your rebuild and install Windows 10 using 64-bit install media, which you can create using the tool at **www.microsoft.com/software-download/windows10** in conjunction with a USB flash drive or blank DVD. You should be given the option of creating 64-bit install media during the setup process.

After installing Windows 10 on your new build – skip the prompt for a product key when prompted – make sure you're signed into your Microsoft account during installation and then head over to 'Settings > Update & Security > Activation' where you should click Troubleshoot to follow the steps provided in the Activation troubleshooter.

Be sure to select your 'old' PC as 'This is the device I'm using right now' to transfer the license across. After clicking 'Activate' the process should be done. If you run into any errors, check **https://support.microsoft.com/en-us/help/10738** for a guide to what the error message means and what to do next. ■

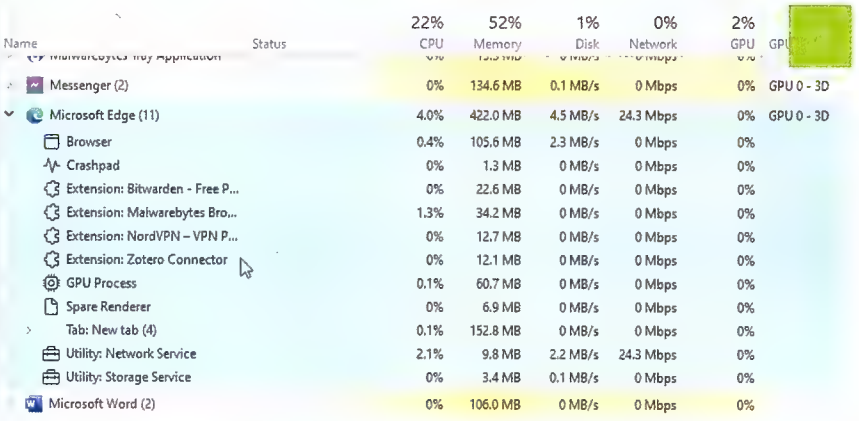
Advanced Windows 11 tips: Task Manager

Nick Peers pulls back the curtain on these essential Windows 11 tips.

In this first tutorial in a new series showcasing how to get more from your Windows 11 setup, we're starting with a detailed look at what's going on under the hood of your machine. You may not currently care that, behind the scenes, your Windows installation is performing a complicated juggling routine involving a tangled web of applications, services, processes, threads, and handles, but we suspect that outlook will change the moment your system starts to slow down, become non-responsive, or prone to crashing.

Knowledge is power, and there are two primary tools that can help you peer behind the scenes to determine what's going on, identify areas of concern, and even in some cases, restore non-responsive applications to life without force-quitting them and losing hours of unsaved work. The first, Task Manager, is built into Windows itself and has all the tools you need to resolve most problems, but if you need an even deeper dive into your PC's software innards, then Process Explorer is the tool for you.

Armed with these tools, you'll discover how to monitor and free up system resources, track down troublesome processes, and generally keep your PC running a bit more smoothly.

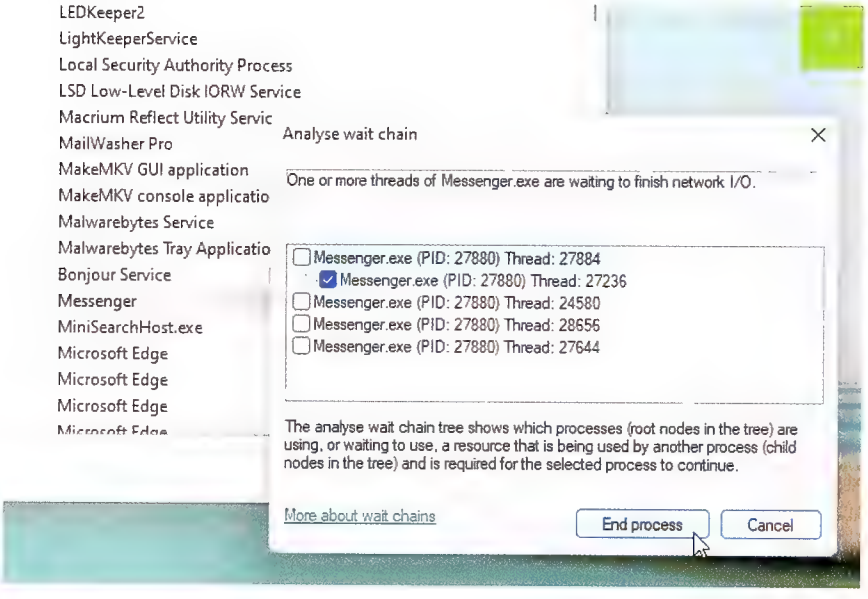


Name	Status	22% CPU	52% Memory	1% Disk	0% Network	2% GPU	GPU
Messenger (2)		0%	134.6 MB	0.1 MB/s	0 Mbps	0%	GPU 0 - 3D
Microsoft Edge (11)		4.0%	422.0 MB	4.5 MB/s	24.3 Mbps	0%	GPU 0 - 3D
Browser		0.4%	105.6 MB	2.3 MB/s	0 Mbps	0%	
Crashpad		0%	1.3 MB	0 MB/s	0 Mbps	0%	
Extension: Bitwarden - Free P...		0%	22.6 MB	0 MB/s	0 Mbps	0%	
Extension: Malwarebytes Bro...		1.3%	34.2 MB	0 MB/s	0 Mbps	0%	
Extension: NordVPN – VPN P...		0%	12.7 MB	0 MB/s	0 Mbps	0%	
Extension: Zotero Connector		0%	12.1 MB	0 MB/s	0 Mbps	0%	
GPU Process		0.1%	60.7 MB	0 MB/s	0 Mbps	0%	
Spare Renderer		0%	6.9 MB	0 MB/s	0 Mbps	0%	
Tab: New tab (4)		0.1%	152.8 MB	0 MB/s	0 Mbps	0%	
Utility: Network Service		2.1%	9.8 MB	2.2 MB/s	24.3 Mbps	0%	
Utility: Storage Service		0%	3.4 MB	0.1 MB/s	0 Mbps	0%	
Microsoft Word (2)		0%	106.0 MB	0 MB/s	0 Mbps	0%	

Quick-fire orientation

Let's start with a quick tour of Task Manager's key features. Step one is opening it – the quickest way is to learn a new three-fingered salute if you haven't already: Ctrl-Shift-Esc (save Ctrl-Alt-Delete for times when Windows won't respond). You can also access Task Manager in Windows 10 by right-clicking the Taskbar, or in Windows 11 by right-clicking the Start button and choosing Task Manager.

The basic Task Manager view is a simple list of running apps, so in the unlikely event you haven't already gone beyond this, click 'More details' to access a more reassuringly packed seven-tabbed dialog packed with useful info. The annotation provides a quick overview of what each section does, but let's take a deep dive and see what each section can provide in terms of useful diagnostic info and troubleshooting tools.

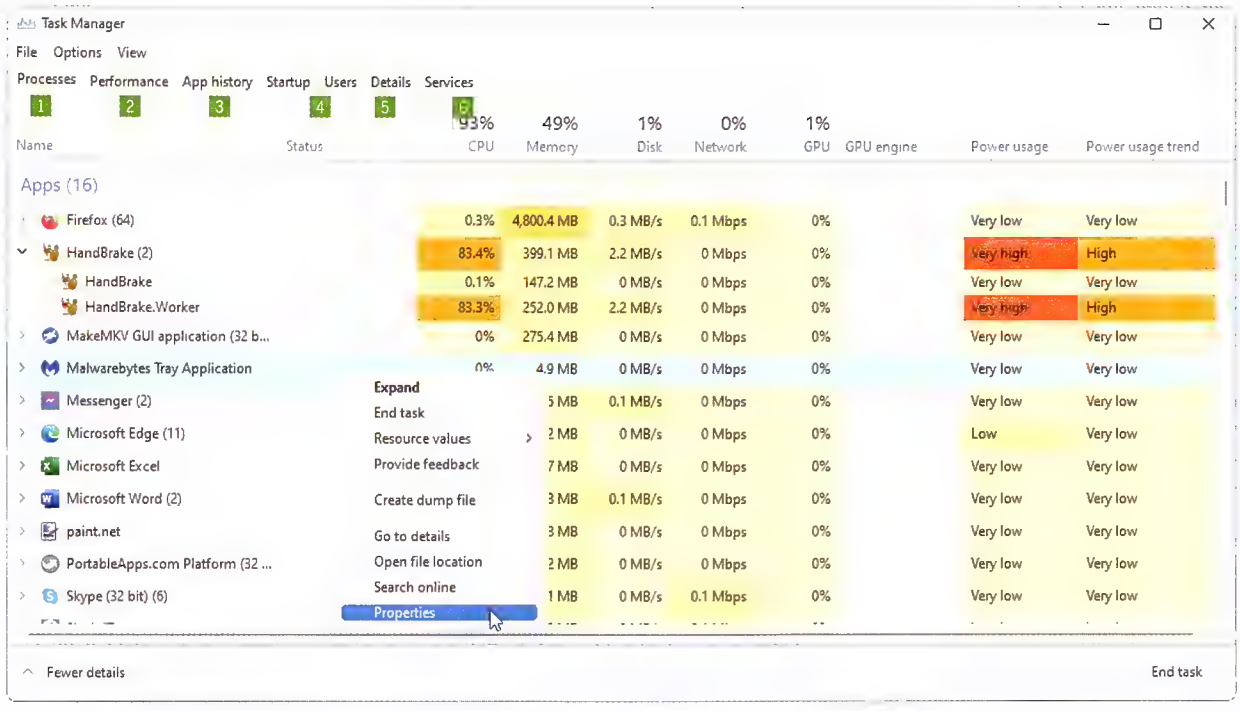

LEDKeeper2
LightKeeperService
Local Security Authority Process
LSD Low-Level Disk IORW Service
Macrium Reflect Utility Servic
MailWasher Pro
MakeMKV GUI application
MakeMKV console applicatio
Malwarebytes Service
Malwarebytes Tray Applicatio
Bonjour Service
Messenger
MiniSearchHost.exe
Microsoft Edge
Microsoft Edge
Microsoft Edge
Analyse wait chain
One or more threads of Messenger.exe are waiting to finish network I/O.
Messenger.exe (PID: 27880) Thread: 27884
Messenger.exe (PID: 27880) Thread: 27236
Messenger.exe (PID: 27880) Thread: 24580
Messenger.exe (PID: 27880) Thread: 28656
Messenger.exe (PID: 27880) Thread: 27644
The analyse wait chain tree shows which processes (root nodes in the tree) are using, or waiting to use, a resource that is being used by another process (child nodes in the tree) and is required for the selected process to continue.
More about wait chains
End process
Cancel

See what's running

The Processes tab is where you'll get a detailed overview of what's running on your PC. It's split into three sections: Apps lists the programs you've launched via File Explorer – to see what processes each app is running, click the > next to its entry to expand the list. In most cases, there may only be a single process listed, or you may simply see multiple threads with the same name as the app itself, but others may provide more useful details. For example, Word will display a separate entry for each document you've opened, while Microsoft Edge goes even further in identifying each separate subprocess [Image A].

Beneath Apps lies 'Background processes', which lists all third-party programs running in the background. Again, some can be expanded, and these may provide more pertinent information about the process, or at least which program launched it. For example, expand 'Anti-malware Service Executable' to discover that it is part of Microsoft Defender's Antivirus component.

The final section is 'Windows processes', which refers to core processes related to Windows, including all running Services. The latter can also be viewed via their own dedicated tab, but one of the benefits of using Processes is that you can review each individual process's resource usage, with columns covering CPU, Memory, Disk, and


Task Manager
File Options View
Processes Performance App history Startup Users Details Services
1 2 3 4 5 6
93% 49% 1% 0% 1%
Name Status CPU Memory Disk Network GPU GPU engine Power usage Power usage trend
Apps (16)
Firefox (64) 0.3% 4,800.4 MB 0.3 MB/s 0.1 Mbps 0% Very low Very low
HandBrake (2) 83.4% 399.1 MB 2.2 MB/s 0 Mbps 0% Very high High
HandBrake 0.1% 147.2 MB 0 MB/s 0 Mbps 0% Very low Very low
HandBrake.Worker 83.3% 252.0 MB 2.2 MB/s 0 Mbps 0% Very high High
MakeMKV GUI application (32 b... 0% 275.4 MB 0 MB/s 0 Mbps 0% Very low Very low
Malwarebytes Tray Application 0% 4.9 MB 0 MB/s 0 Mbps 0% Very low Very low
Messenger (2) 5 MB 0.1 MB/s 0 Mbps 0% Very low Very low
Microsoft Edge (11) 2 MB 0 MB/s 0 Mbps 0% Low Very low
Microsoft Excel 7 MB 0 MB/s 0 Mbps 0% Very low Very low
Microsoft Word (2) 3 MB 0.1 MB/s 0 Mbps 0% Very low Very low
paint.net 3 MB 0 MB/s 0 Mbps 0% Very low Very low
PortableApps.com Platform (32 ... 2 MB 0 MB/s 0 Mbps 0% Very low Very low
Skype (32 bit) (6) 1 MB 0 MB/s 0.1 Mbps 0% Very low Very low
Expand
End task
Resource values
Provide feedback
Create dump file
Go to details
Open file location
Search online
Properties
Fewer details
End task

TASK MANAGER AT A GLANCE

1 PROCESSES
This tab offers a handy view of everything – from Store apps and desktop programs to background services – running on your PC. Items are split into three sections: Apps, Background processes, and Windows Processes.

2 PERFORMANCE
From here, you can monitor the performance of key hardware. A chart provides historic data for the past 60 seconds, while you also get to see real-time stats and key info about each component.

3 APP HISTORY/STARTUP
While the former provides a means of monitoring the resource usage of any running apps you've installed through the Microsoft Store, the latter offers a comprehensive list of programs and apps set to start with Windows, complete with a rough estimate of their impact on start-up times.

4 USERS
If multiple users are logged on to your PC, use this tab to see what processes each user is currently running. Of course, this will be of limited use to single users.

5 DETAILS
Potentially the most useful part of Task Manager, this section provides you with information – and control – over running processes.

6 SERVICES
Get a quick overview of running Services. You can start and stop them from here or jump to the more fully-featured Services tool.

Network. Click a column header to quickly sort the list by which process is taking up the most resources.

To find out more about a process, right-click it and choose Properties > Details tab or choose 'Search online' to perform a Bing-powered search for both the process name and its underlying filename. If you're troubleshooting an app, choose 'Create a dump file' to create a file you can share with a professional or review yourself using the free WinDbg Preview (install this through the Microsoft Store).

Recover frozen apps

One major use of Task Manager is, of course, ending non-responsive programs or processes to free up your PC. You'll be aware that such processes are usually highlighted and selecting the process and clicking the 'End task' button (sometimes more than once) is usually enough to end it. One exception is File Explorer (or Windows Explorer as it's listed) – when you select this, 'End task' is replaced by a 'Restart' button, which does what it says on the tin.

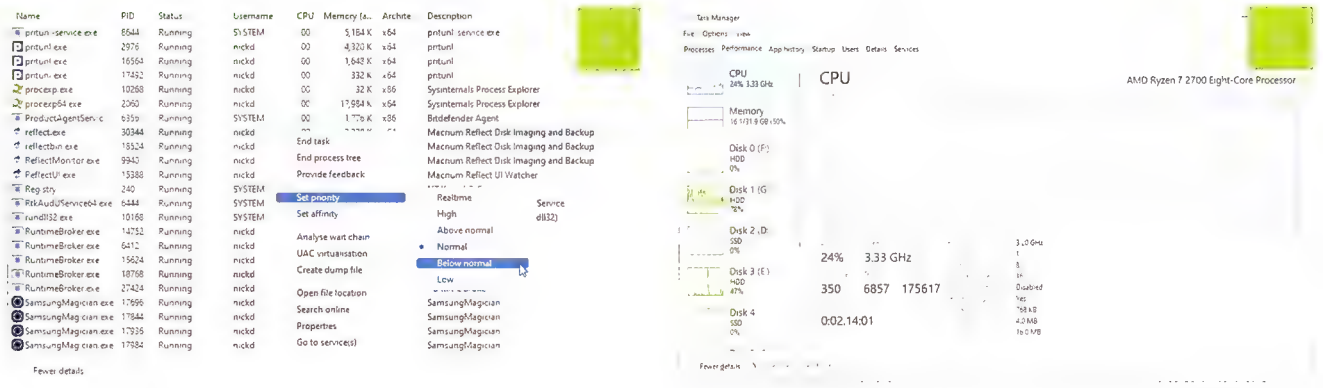
But what if you're about to potentially lose a load of data because you've been lax about saving documents? With a bit of luck, you may be able to recover the program by identifying and terminating the exact thread holding things up, which may be enough to coax the app back to life without crashing.

To do this, right-click the errant process and choose 'Go to details' to switch to the Details tab where you'll find processes are listed alphabetically with lots more potentially useful info: their status (running or suspended), the user who launched them (typically you, SYSTEM or a SERVICE) and a PID (Process ID).

To try and free up a non-responding thread from here, right-click it again and choose 'Analyse wait chain'. This will list any threads that are using or waiting to use resources being used elsewhere [Image B]. Ending the thread may be enough to free up the original process – we've done this a few times in Firefox when an individual tab has become non-responsive, for example.

OptimiSe app performance

There are some other handy options under the Details tab – you can alter thread priorities here, which in turn can stop particular processes from taking over your PC and slowing everything else down. This is more an issue with low-powered PCs (in which case, take a look at Process Lasso (**https://bitsum.com/**) for an automated solution), but if you'd like to experiment, right-click the offending process and choose 'Set Priority > Below Normal' to see if it helps to rein in resource hogs [Image C]. You can also give threads more priority if you feel they need extra attention but



avoid giving any thread 'Realtime' priority as it will bring Windows grinding to a halt.

Another option is 'Set affinity'. This may have performance benefits for older programs designed during the days of single-core processors – the setting basically allows you to limit an app to using specific processor cores – but in most cases, Windows knows what it's doing, so is largely redundant.

Monitor performance

The Performance tab allows you to monitor the effect your currently running system is having on key hardware components: CPU, RAM, disks, network, and GPU are all covered. You get a graph providing you with 60 seconds of past performance [Image D], plus key stats about current resource usage as well as some handy info about the component in question (for example, whether hardware virtualisation is currently enabled for your CPU).

If you'd like to monitor the cumulative effects of individual apps in terms of CPU (processor time used) and network (amount of data transferred), then switch to the 'App history' tab. By default, it only shows apps installed through the Microsoft Store but you can change this to show all processes by selecting 'Options > Show history for all processes'. To reset the stats and start recording again, click 'Delete usage history'.

Streamline start-up

It's amazing what apps configure themselves to automatically start with your PC. Task Manager's Startup tab provides a comprehensive view of what's set itself to start with Windows – even apps missed by third-party tools like BootRacer. Better still, Task Manager offers a 'Start-up impact' rating for each app to help you identify those taking the most resources, although it frequently, and disappointingly, lists 'Not measured' next to many. Click the 'Start-up impact' column header to sort the list to show those with a high impact first.

Most apps configure themselves to start with Windows simply to save a bit of time when you launch them, so if you rarely use the app, select it and click the Disable button to shave seconds from startup as well as reclaim memory and CPU resources.

Determine process relationships

Task Manager can tell you a lot about individual processes, but one thing it doesn't do is demonstrate how they're interconnected. To dig even deeper into what's running on your PC, we recommend Process Explorer, a free tool from Microsoft's Sysinternals team. No installation is required, simply download ProcessExplorer.zip from **https://docs.microsoft.com/en-us/sysinternals/downloads/process-explorer** and then extract the ProcessExplorer folder from inside it. Open this and you'll find three executables to choose from: procexp.exe contains both 32-bit and 64-bit versions, so right-click this and choose 'Run as administrator'.

Process Explorer opens to display a colourful, multi-columned window that's like Task Manager's Details view. One difference is that processes are nested inside other processes. This provides a breadcrumb trail of what program spawned what, helping you identify where specific processes came from.

Scroll down the list and you'll see a host of familiar programs appearing under explorer.exe – any program opened in the usual way (via the desktop, Taskbar, or Start menu) will appear here. If you subsequently opened a program via another program, then the target program, Paint.NET in the example shown [Image E], will appear nested inside its parent, which is WinSnap here.

The colour coding helps identify what's going on with each process – choose Options > Configure Colours… to see what each color represents. You'll notice most processes under explorer.exe are lilac, or 'Own Processes', which means they're running under the same account as Process Explorer, typically your own. Keep an eye out for purple processes, these 'Packed Images' may contain compressed code, a possible sign of malware.

Get a granular view

Even when you lose the multi-nested view in Process Explorer, you can still identify which parent a process belongs to by double-clicking it to open a comprehensive, multi-tabbed Properties dialog. You'll open to the Image tab, where

TERMINOLOGY 101

Throughout Task Manager and Process Explorer, you'll find references to programs, processes, handles, and threads. What do they mean and how do they relate to each other?

Programs are sets of files required to run an application, whether it's a game, web browser, underlying Windows programs, such as File Explorer, or background Services.

Processes provide the resources required to run the executable program. These are stored in a reserved portion of RAM (physical and virtual) known as 'virtual address space', and include the program files, plus open 'handles' to system objects. They're assigned a security context, which determines their level of access to the system, a unique process identifier (PID) for identification, memory limits ('working set sizes'), and a priority class, which determines how fast they can run in relation to other processes.

Handles determine what resources each process requires (such as DLL files or Registry entries), as well as environment variables. Each process is then split into threads, which allows Windows to allocate processor time between them. Each thread can execute any part of the process's code – even parts being executed by other threads – and shares the process's virtual address space and resources. They have their own properties, such as unique identifiers and exception handlers, and are designed to stop and start to a schedule, so they don't all run at once.

TRACK YOUR SYSTEM

If you'd like to keep Process Explorer running in the background, click Options to open the menu and tick both 'Hide When Minimised' and 'Allow Only One Instance'. This means you'll always be able to access Process Explorer from the Taskbar notification area, plus you'll prevent multiple instances of the app from running.

Process Explorer's icon displays a real-time chart of CPU usage – roll your mouse over it and a pop-up will display overall CPU usage as a percentage along with the most demanding process currently running. You can alter these metrics via Options > Tray Icons. Choices include GPU memory and Commit, which gives you an estimate of how much memory your system may need based on its current usage. If your system appears sluggish, you can glance at this then open Process Explorer for a wider view.

Look carefully at the System process. You'll see an entry marked 'Interrupts'. This is an artificial process that tracks the system's interaction with your hardware. If you spot high CPU consumption for this figure, then it indicates a potential problem with your hardware or, more likely, a driver bug. Don't bother clicking it for further information, though – there's nothing to see, literally.

the process is listed along with its parent, which user it's running under, its autostart location (if relevant), and even the command line argument used to launch it. The Image tab also provides controls for confirming the validity of a program's digital signature (click Verify) as well as an option to submit the file to VirusTotal for a quick malware check – recommended if the process is colored purple [Image F].

Other useful tabs include Performance, Performance Graph, and GPU Graph for measuring that process's specific use of resources. Visit the TCP/IP tab to monitor what remote network connections, if any, a process is using. You can even see what environment variables a process has set up via the Environment tab, which often provides more clues to its origins.

One of the many ways in which Process Explorer allows you to see what's really happening under the hood is through its support for showing detailed information about a process's threads. Switch to the Thread tab – ignoring the warning about missing symbol files – and you'll see a list of all threads associated with that process. You get to see the CPU usage for individual threads as well as the files calling that thread, which helps pinpoint where a resource leak may be occurring. You can technically kill or suspend individual threads from here, but save any work before doing so – you could easily bring down the parent process, or even Windows itself, if you don't know what you're doing.

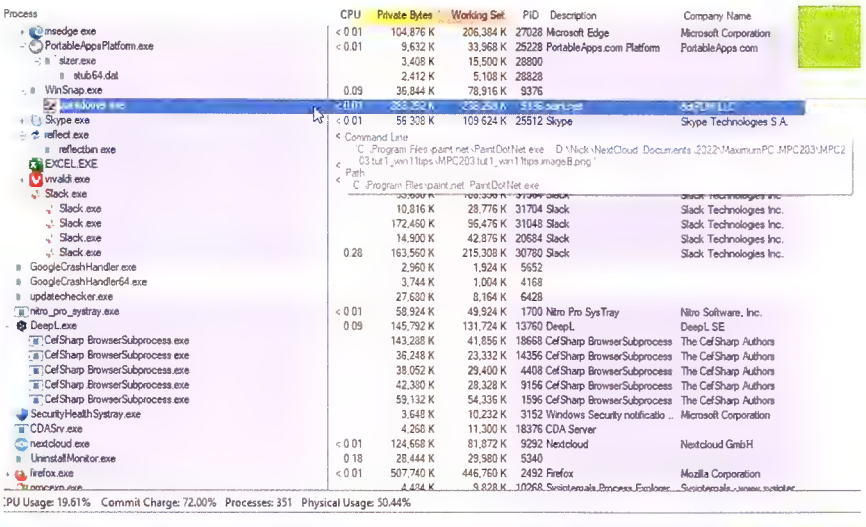
Handles and DLL files

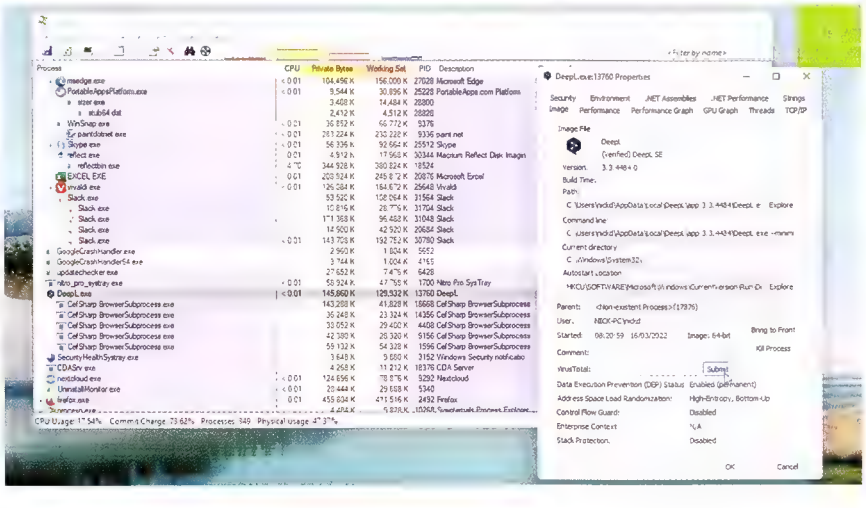
Process Explorer also lets you take a close look at a process's handles and DLL files, which are the resource files that can be shared between multiple programs. Select your thread and press Ctrl-H – a new pane will appear listing its handles. From here, double-click a handle to get more information about it (most specifically, a description of the handle type, such as 'Section' or 'WindowStation'). It's technically possible to close individual handles by right-clicking and choosing the 'Close' option, but as with threads, if you don't know what you're doing, it's likely you'll bring the whole process crashing down.

Press Ctrl-D and the lower pane switches to DLL view, listing all the DLL files that the process in question is accessing. Double-click a DLL file to access its Properties – switch to the Strings tab and you'll be shown a list of string values it contains. Press Ctrl-H to switch back to Handles view, or Ctrl-L to toggle the lower pane on and off.

What does this information tell you? It gives you detailed insights into what makes up a process – how it's made up of multiple threads and what resources it uses in the forms of handles and DLL files. Not only does it let you see what's happening with individual processes, it also helps you learn how programs and processes run.

Handles are also useful for identifying which process is preventing you from deleting a file because it's open elsewhere. Choose 'Find > Find Handle or DLL' and enter the name of the offending file. Click Search, and a list of processes using the file will be displayed. Closing these should allow you to delete the file. ■





ANOTHER WINDOWS 11 TUTORIAL NEXT MONTH!

APPLE MAC

Rename multiple files

The Finder in macOS allows you to rename files in batches. Kenny Hemphill shows how it's done.

IT WILL TAKE
30 minutes

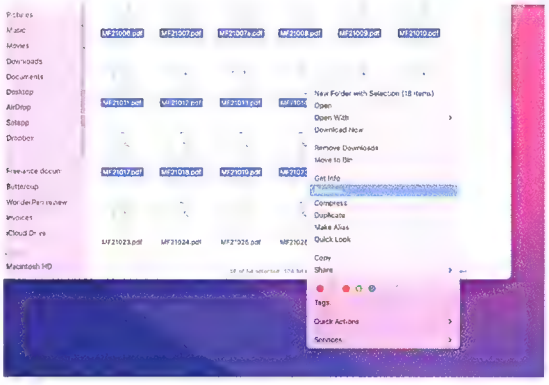
YOU WILL LEARN
How to rename lots of files at once in Finder

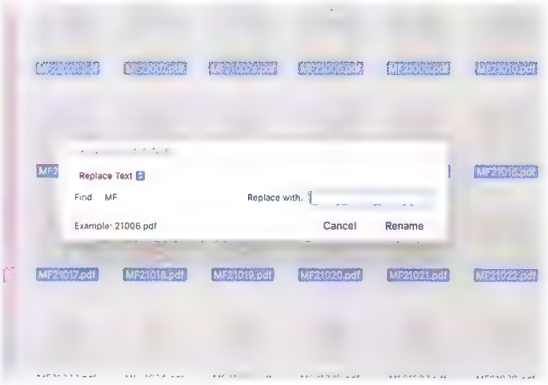
YOU'LL NEED
OS X 10.10 or later

There are many reasons why you might find yourself needing to rename lots of files at the same time. Perhaps you've transferred photographs or videos from a memory card and want to be able to identify them better, or organise them by date, location, or occasion. Or perhaps you've used a disk recovery tool to retrieve data from a failed drive and want to quickly organise the files that you've saved from permanent deletion. Whatever the reason, until a few years ago, there was no way to do it without using a third-party tool or writing your own script or Automator action.

In OS X Yosemite, however, that changed with the introduction of a renaming tool in the Finder. But it's one of those features that gets little attention, so many Mac fans don't even realise it exists. You can use it to replace text in a file name, append text to a filename, or replace a whole filename. In this tutorial, we'll show you how to use it to rename groups of files in different ways.

HOW TO Batch rename files in the Finder

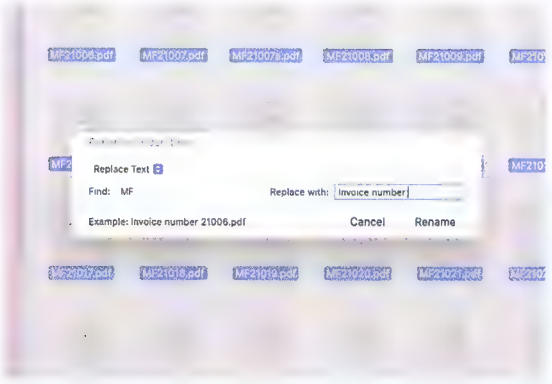




01 Select the files
Locate the files you want to rename in Finder. command-click on each file. When you've selected all the files you want to rename, control-click on them and choose Rename, or click File > Rename.

02 Replace Text
In the dialog that appears, choose Replace from the menu. In the left-hand box next to Find, type the text you want to replace in the name of the file. For example, 'DSC' in the name of a photo.

GENIUS TIP!
If you need more options than the Finder offers, there are third-party tools. One of those is the venerable A Better Finder Rename.

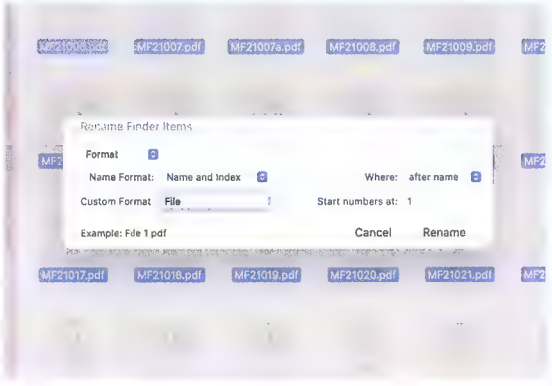


03 Finish replacing text

Next, in the 'Replace with' field, type the text you want to replace the text typed in the Find entry. Note that it will be used in multiple files, so shouldn't be too specific. Click Rename to replace the text in all the filenames.

04 Add Text

If you want to add text to the filename, rather than replace existing text, choose Add Text from the menu. Type the text you want to add, then choose 'before name' or 'after name' from the menu and click Rename.

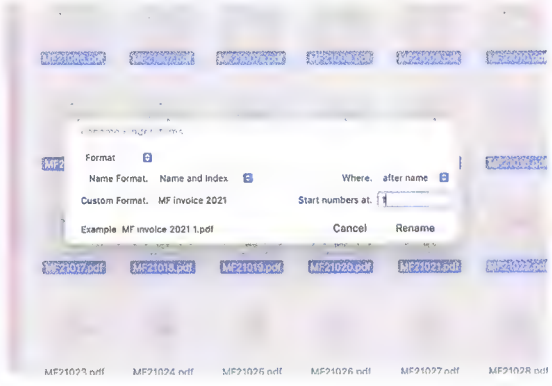


05 Format the name

The Format option enables you to replace all the text in a filename with new text and a number. The text is the same for all files, while the number increases by one for each file. Choose Format from the menu to use it.

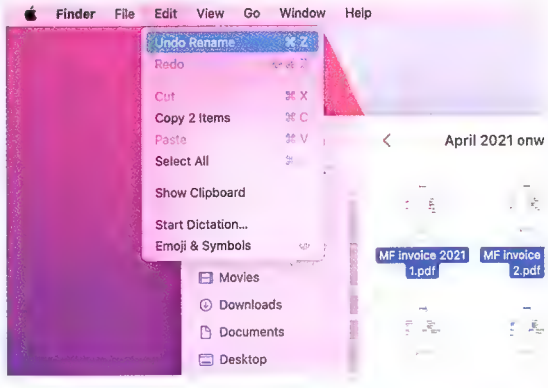
06 Choose an option

Choose one of the options from the Name Format menu. Name and Index, which adds an integer, Name and Counter which adds '0000' before the integer, or Name and Date which adds the date and time after the name.



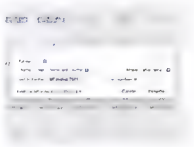
07 Finish formatting

Choose where the index, date or counter should go, type the name in the Custom Format field, and type a number in the 'Start Numbers at' box if you've selected Name and Index or Name and Counter. Click Rename.



08 Undo the rename

If you realise that you've made a mistake after you click Rename, or if you change your mind when you see the results, choose Finder > Edit > Undo Rename. Or press command-Z to undo the most recent change. ■



JARGON BUSTER
Index and Counter
The benefit of using counter rather than index is that the option ensures files are sorted in numerical order by all apps.

GENIUS TIP!
Remove text
If you want to remove text from file names rather than replace or add to it, use the Replace Text option and leave the Replace box blank.

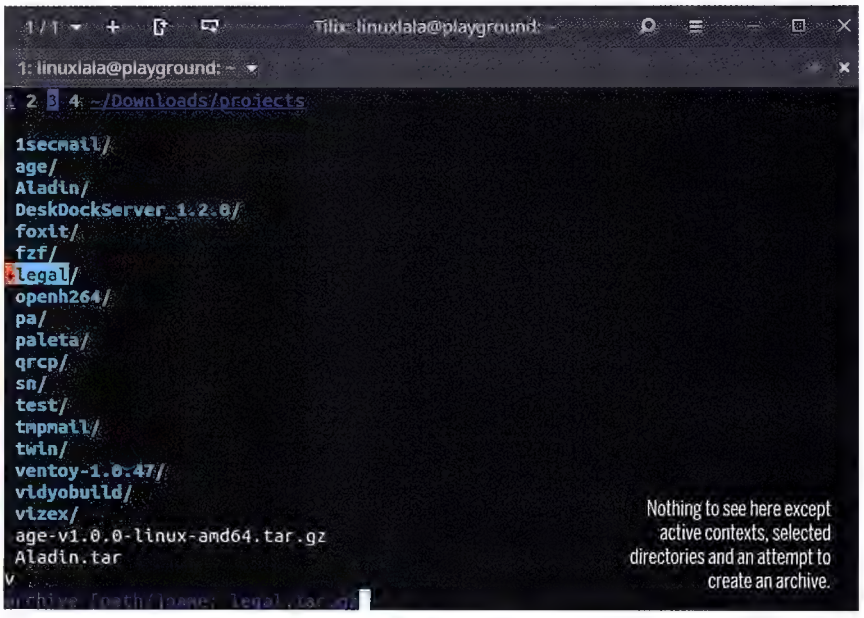
Discover the super-charged file manager

The problem of plenty has long plagued GUI managers where many tools offer similar features. Shashank Sharma recreates the situation on the CLI.

We've previously discussed the FFF file manager here, which scoffs at traditional file managers in its appearance and functionality. Our tool of choice this issue, nnn, is cut from the same cloth. The project was originally forked from Noice, which is a small ncurses-based file manager, hence the name Noice is Not Noice (nnn), but the project has since dropped the acronym and now prefers to be known only as nnn, or n³.

Many distributions carry nnn in their software repositories and the project's GitHub page (**https://github.com/jarun/nnn**) provides a list of these, and the version of nnn on offer. Unfortunately, many distributions carry older versions of nnn in their repositories, but if you're running the latest releases of Debian 12, Fedora 34+. Arch, or Void Linux, you'll find the latest 4.4 release in the software repositories. Additionally, nnn utilises openSUSE's build service to provide installable binaries for distributions such as Fedora, Debian and Ubuntu. If you're either unwilling or unsure about installing it from source, the project also provides a portable static binary, which enables you to use nnn without installation.

If you're running Ubuntu, grab the package for your distribution from the OBS service and then install it with the **sudo dpkg -i nnn_4.4-1_amd64.deb** command. Unlike most other CLI tools, nnn doesn't have a man page. But you can learn all about working with the feature-rich file manager from the GitHub hosted wiki (**https://github.com/jarun/nnn/wiki**), which is split into different sections such as Installation and Configuration.



Some would argue that a file manager's purpose is to help you navigate the directory trees on your disk, and help you perform functions such as copying, moving, deleting or renaming files.

Some would argue that a file manager's purpose is to help you navigate the directory trees on your disk, and help you perform functions such as copying, moving, deleting or renaming files. Depending on the action in question, you might want to operate upon a single or multiple files. While nnn can do all these without a hitch, the quirky little tool has a lot more on offer.

Unfortunately, we're constrained by space to go over its entire feature list. Even better, you can also expand

WORKING WITH BOOKMARKS

Long-time readers will remember Buku, a useful directory bookmark utility we discussed. You can find the same functionality in nnn, and can create bookmarks for frequently accessed directories. Bookmarks are defined using a key_char:location pair.

For instance, you can have D as a bookmark for **~/Downloads** directory. To do this, run the **export NNN_BMS="D:~//Downloads** command.

All key_char:location pairs must be separated by the ; key. The command **export NNN_BMS="d:$HOME/downloads;p:~/Downloads/projects;t:/media/linuxlala/Stuffsies"** creates three bookmarks. You can view all the bookmarks from within nnn by pressing ?. All user-created bookmarks are listed under the BOOKMARKS heading.

You must add the export command to your **~/.bashrc** file, and remember to run the **source .bashrc** command every time you create a new bookmark, if you wish to retain it for future nnn sessions. To access a stored bookmark, press b, and nnn will display the available key characters used to create bookmarks. In our case, when we press b within a context, nnn shows 'd D' at the bottom of the screen. Press the key corresponding to the directory you wish to access.

In addition to creating permanent bookmarks, you can also set up a temporary bookmark, called pinning or marking a directory in nnn speak, by pressing , (comma). You can only pin one directory at a time. You can press b and then , to switch to a pinned directory.

nnn with plugins, which are a mixture of useful and quirky. Whether it's reading ebooks, creating and performing chksums, viewing images or setting them as wallpapers, splitting or joining files, creating an mp3 ringtone that you can use on your phone or integrating with fzf, all these tasks can be accomplished with nnn, if you install the right plugin. For most of the plugins, you'll also have to install their dependencies.

Out of the way basics!

When you first launch nnn with the `nnn` command, you'll immediately notice its spartan appearance. You're greeted with a list of all the directories in your current working directory, and little else. You can navigate through the screen using the arrow keys or if you're a devoted CLI junkie, using the Vim navigation. You can navigate into a directory by pressing either Enter or the right arrow key. You can similarly use the Backspace or the left arrow key to move to the parent directory.

When running nnn inside a desktop environment, the tool respects your file associations and open files in the default external application associated with the file type. For a list of all the keyboard shortcuts, press ?. You'll find the shortcuts are split into different categories such as Navigation, Filter & Prompt, Files and Misc.

You'll also notice that the nnn interface features four numbers at the top of the screen. These are called 'context' in nnn speak, but you can think of them as tabs. Each tab can be configured to default to different directories and settings. You can switch between the different contexts using the number keys 1 through 4. The currently active context is highlighted with a blue box. The file manager also identifies in-use contexts by underlying their respective number. If you've only just launched nnn, context 1 would be highlighted. Press 3 and you'll see what we're talking about.

Before you can exit nnn, all contexts must be closed. If you didn't use any contexts other than the default, pressing q will exit nnn. However, if you used the different contexts by pressing the number keys 1 through 4, then each time you press q, one context will close. That is, if you've used all the contexts, you must press q four times to exit nnn, but only twice if you only used two contexts. You can bypass this and immediately close nnn regardless of how many contexts you were working on by pressing Q, which makes nnn ask for confirmation to quit all contexts at the bottom of the screen. Press y to exit.

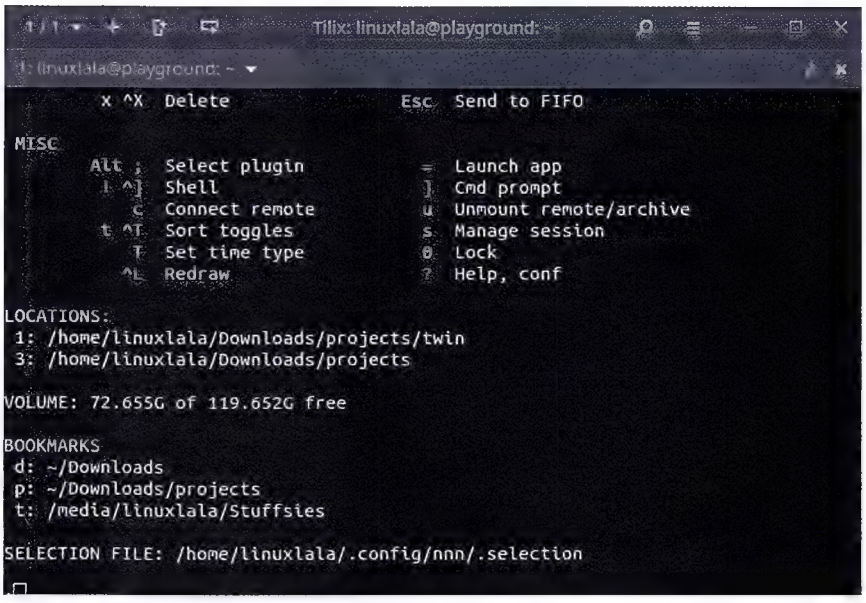
File operations

The need and usefulness of contexts becomes clear when you have to move or copy files. You can have the source directory open in one context and the destination, which simplifies the process.

To select a file, navigate through the directory and then press the Space bar. You'll notice an orange-coloured + sign appear to the immediate left of the chosen file. Keep scrolling and selecting the files you want. Now use a different context to navigate to the destination directory and press p. This copies the selected files. If you prefer to move files instead, press v.

An interesting thing about this approach is that your selection can span multiple directories, across different contexts, and nnn has no problem performing any operation on the selected files as you see fit. For instance, from context 1, select two files from the ~/**Documents** directory, and then navigate to ~/**Downloads** and select another files. Now press 2, and in the second context navigate to ~/**Pictures** and select another five files. When you select the destination directory in context 3 and press p, nnn will create a neat copy of all the selected files.

You can similarly press x to delete the selected files. When deleting files, nnn will ask you to confirm the action. Notice the `rm -rf hovered [Esc cancels]` message at the bottom of the screen? You must press y to confirm delete, but note that this action isn't reversible. Files once deleted can't be recovered. We're not playing games here people!



The ? key lists more than just keyboard shortcuts. It will also provide a list of all user-created shortcuts, as well as the current directory for each active context.

When running nnn inside a desktop environment, the tool respects your file associations and open files in the default external application associated with the file type.

Useful features

If you ever need to access the shell while working with nnn, you have two choices, You can either press the ! (exclamation key) to be dropped to the full-fledged shell, or press] to open a command-prompt. Toggle files as executable by selecting them, and then pressing *.

In another departure from convention, nnn doesn't utilise config files. Instead, it supports a number of environment variables that can be used to perform myriad tasks. See the box (*opposite*) to learn how to use the NNN_BMS variable to create bookmarks with nnn.

There's still more that you can do with nnn, such as utilise the built-in filtering feature, which provides a search-as-you-type functionality to quickly locate the file or directory you're after.

But as the project lacks a man page, you should make it a point to thoroughly study the GitHub page, as well as the wiki to make sense of the vast feature set of nnn. Should you run into any troubles, you can open a new issue and report the problem, but chances are that a solution is already available, so search through the listed issues first.■

QUICK TIP

You can use uppercase and lowercase letters to create bookmarks as well as number keys, apart from 1 through 4, which are configured for switching between different contexts.

Create your own Chromecast device

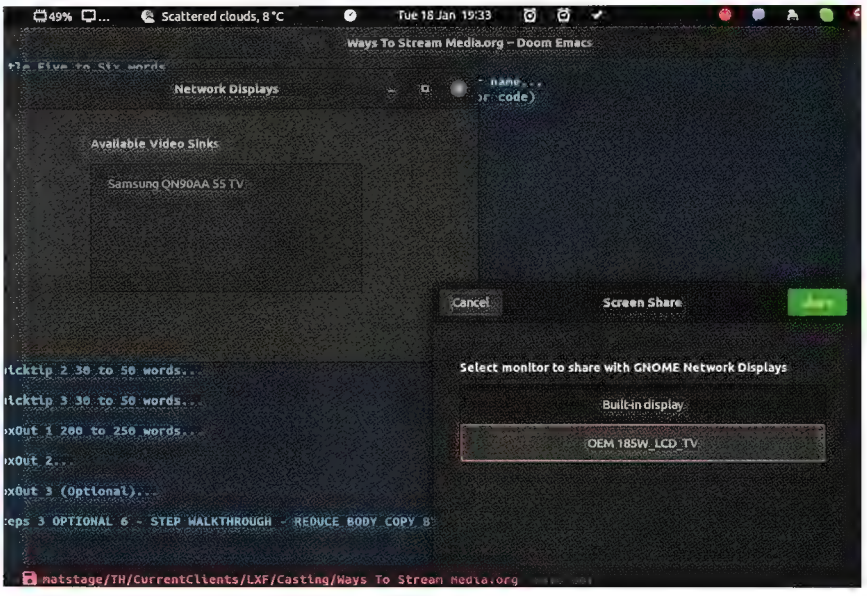
Mats Tage Axelsson takes you on a tour of the Linux tools that will enable you to stream media between your laptop and other devices.

We all spend an inordinate amount of time consuming video and music. Many of these services are streamed via browsers, but that's not always the best way to enjoy it. Another key issue: where to display it? Sure, you can watch videos on your laptop – and let's face it, you probably do – but how often do you just hop over to the sofa to continue enjoying a classic album or the latest must-watch TV series?

With the correct setup, you can make this happen. You can also store your own media on a server and stream it to your TV or other devices. This is where casting methods and media servers come in, but currently the world is a confusing collection of Google Chromecast, Amazon Fire sticks, Apple whatchamacallits and a host of other device-based screen-sharing systems. So let's delve into the protocols and see how it all works.

To do this, you'll need to set up your software. For the simplest cases, everything is available by default from your distro, but better alternatives keep appearing. You may also be able to tweak things to your preferences, especially when you're creating your own content. In this article, we'll present you with our suggestions for your own journey to media mastery.

Once you've selected a suitable 'sink', you have a corner marker indicating that you're sharing the screen with other devices.



GNOME Software Displays starts by requesting your shared screen and then identifies "sinks" aka suitable connections.

Stream or cast?

Let's start by explaining the two main concepts: streaming and casting. To stream media, you send your media from somewhere for others to watch – typically this is a show of some kind. It's what YouTubers do when they're broadcasting live. Casting refers to the end user: how you can make your incoming stream go to a specific device (aka a sink). There are different protocols involved with both these activities.

Usually, you don't need to worry about which protocols are used until you have to choose them for your server. Still, if you know and run Linux then, as ever, you have choices. You may be able to improve the quality of your media, or use a package that's already on your computer.

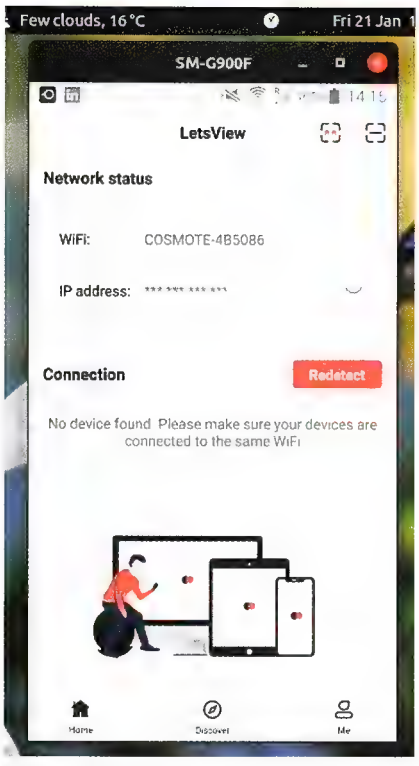
Some of the protocols you hear about will involve specific needs. For example, the RTSP protocol supports video directly from cameras. You can use this protocol for video casting over Wi-Fi. Other protocols that you need to consider are the ones that stream to different sites such as Youtube (RTMPS) or Facebook (WebRTC). Note that you may use one protocol to send your media files as opposed to watching.

You can also use the RTSP protocol for a first-person viewer drone. The big problem with RTSP is limited browser support. Having said this, there's a gstreamer1 plugin in the apt repositories and a Perl server. The main server, though, is the crmtpserver. It's a compact and efficient way to connect to video-conferencing, surveillance cameras and your smartphone.

Apple introduced HLS or HTTP Live Streaming in 2009 to replace Flash from its phones. It's become extremely popular – so much so that it's the

QUICK TIP

If you try to download a library for your project and apt-get fails due to wrong dependencies, you can use the deb file. The dpkg command may permit the install, though you must repair your system with **apt-get --fix-broken install** after you've run the compile.



Lots of casting software is available, and one example is LetsView. This application searches for "sinks" (targets) that support MiraCast, which tend to be TVs.

default for HTML5 video players. Which means you're using it every time you watch videos on YouTube. Creating (ingesting) video content is a bit more problematic because encoders are either rare or expensive. However, there are players available to do this, such as the one at **https://nageru.sesse.net**. This project is still in alpha. Fortunately, you can create video with other protocols.

If you're especially interested in streaming to YouTube, you can find both API-samples on GitHub (**https://github.com/youtube/api-samples**), and OBS supports it natively.

One cast to rule them all

One of the earliest projects to make streaming over Wi-Fi simple and direct between devices was Miracast. The effort led to the Miracast standard. It's still in use, although Android has dropped official support. Despite this, you can use your Android device to stream videos to your smart TV and other devices. Android applications that do this are AirDroid, LetsView and AllCast. Many manufacturers also have added support to their software and devices.

The reason Google and Apple dropped support was that they developed their own in-house solution. Efforts to improve the Miracast standard are still ongoing – this is why it's still in use. Many display manufacturers that are also on the market support the standard.

On Linux, you can use GNOME Network Displays, which works on other desktop environments despite its name. The software enables you to choose which screen to share, and then you can view it on other machines.

If you need another option, you can also compile the code of the MiracleCast project (**https://github.com/albfan/miraclecast**). This is a separate project that's still working on the Miracast standard to make it Linux compatible. If you want to try it out, you can download the code and compile it yourself.

The package has very few dependencies and so should compile on all modern systems. You can even choose from three build systems: Autotools, CMake and Meson. Here's the short version using CMake. Before you start compiling, make sure you have the required packages installed.

```
$ sudo apt install cmake libglib2.0-dev libudev-dev libsystemd-dev libreadline-dev check libtool
```

Download the MiracleCast package using git (save it in any directory).

```
$ git clone git@github.com:albfan/miraclecast.git
```

Git creates the **miraclecast** directory – move into it and start the procedure.

```
$ cd miraclecast
```

Create a new build directory for *CMake* to work from and move into it.

```
$ $ mkdir build
$ cd build
```

Set the environment variable that places MiracleCast in the correct places for your system.

```
$ cmake -DCMAKE_INSTALL_PREFIX=/usr/local ..
```

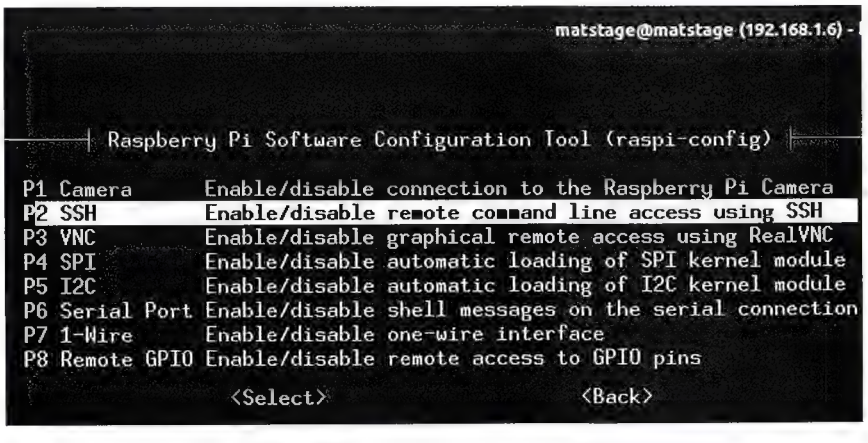
Compile the object files:

```
$ make
```

Install the finished binaries:

```
$ make install  # May require `sudo`: `sudo make install`
```

You can combine these commands with **&&**, but since only **make install** requires sudo it's better to split them up. Tracking down errors is also easier if you take things one step at a time. If everything goes well then you now have MiracleCast installed on your system. To use it, you have a few more steps to follow. The best way to continue is to use the utilities in the **res/** directory in the source tree.


matstage@matstage (192.168.1.6) -
Raspberry Pi Software Configuration Tool (raspi-config)
P1 Camera Enable/disable connection to the Raspberry Pi Camera
P2 SSH Enable/disable remote command line access using SSH
P3 VNC Enable/disable graphical remote access using RealVNC
P4 SPI Enable/disable automatic loading of SPI kernel module
P5 I2C Enable/disable automatic loading of I2C kernel module
P6 Serial Port Enable/disable shell messages on the serial connection
P7 1-Wire Enable/disable one-wire interface
P8 Remote GPIO Enable/disable remote access to GPIO pins
<Select>
<Back>

To configure your Raspberry Pi to enable the SSH server, use the 'Interface Option' in the raspi-config tool.

JUST SHARING YOUR TERMINAL?

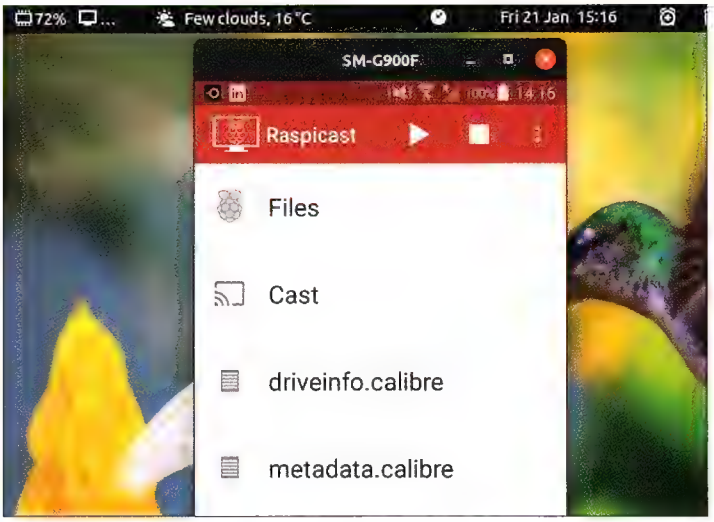
If you're only showing commands on your terminal, using OBS (Open Broadcaster Software) may be overkill. In this case, you can use a command line-only solution. There are several that can do it. A competent one is Terminalizer, which is written in JavaScript.

With Terminalizer you can show all your actions on a terminal and upload them to the web. The program is useful both as a way to show your terminal commands and for re-running a sequence. There isn't an extensive list of features for the program, but both playing and recording facilities are available.

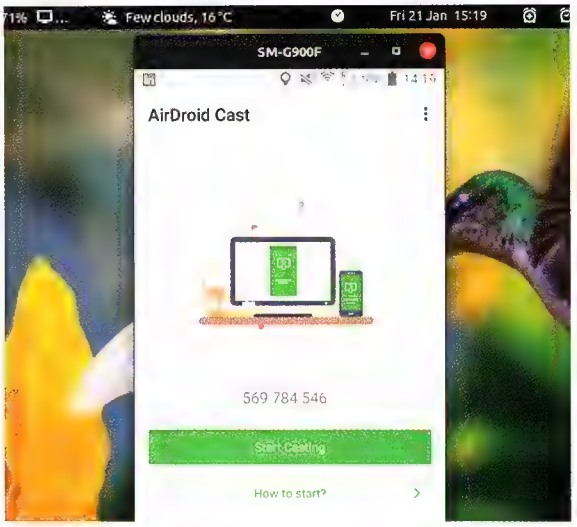
As many other help programs like this, you can publish directly to their web page. However, you're not forced to use their web page because there's already a built-in Gif generator. A web generator that creates a complete player for your web page is also in the works.

The output of your session is saved as a YAML file that you can edit, although it takes some skill to do that. On top of the file you have the settings containing font terminal width and importantly a watermark option. The watermark option leaves your logo on the animated Gif, giving you a chance to promote yourself while helping other people learn Linux.

You can find Terminalizer at **https://terminalizer.com**.



Designers wrote RaspiCast to interface directly with a Raspberry Pi, although you can add many more functions to your Pi.



AirDroid Cast requires a PIN to get started. You verify this on your MiraCast-enabled TV. It's 'Interface Option' in the raspi-config tool.

```
$ cd res
```

To make this work, you must stop ordinary Wi-Fi – the shell tool *kill-wpa.sh* will do this for you. When you've finished, use the *normal-wifi.sh* script to restore your Wi-Fi connection. Note that this is for experimenting with *MiracleCast*. It runs via the command line and you need to be skilled and patient with the options.

The Pi cast

To send your media from your mobile to a Raspberry Pi, you just need to install a few more libraries on top of your standard distro. Because it's Raspberry Pi, Raspian is the most common so this is the reference. To get started with an already running Pi, you make sure you have an updated system.

```
$ sudo apt-get update
$ sudo apt-get upgrade
```

To both be able to run the *RaspiCast* tool and manage your system remotely, start SSH. You can enable SSH using the *raspi-config* tool or using the command line. Check the current state of ssh before you do anything.

```
$ systemctl status ssh
```

To make ssh start at each new reboot, enable ssh.

```
$ sudo systemctl enable ssh
```

The command doesn't start an inactive service. It creates links that start the system during boot. To start ssh in the current session, use the **start** command.

```
$ sudo systemctl start ssh
```

You have the option to either start, enable or both. For this to keep working, though, you must enable and start the service. Using the *raspi-config* tool is another way of doing it. The tool will start and enable the service.

```
$ sudo raspi-config
```

When the tool is running, go to Interface Options, find SSH and select Yes. Now you're set to go with SSH on your Raspberry Pi. Next, you'll need more libraries to compile your image and video viewers. You can pick the code up from GitHub. Create a temporary directory for the code and **cd** into it.

```
$ mkdir viewers && cd viewers
$ git clone https://github.com/HaarigerHarald/omxiv
```

You'll be in this directory later in the process to compile your viewers but first, you can find the libraries you need in the **README.md** file. They may change by the time you start your project, but below are the current ones.

```
$ sudo apt-get install libjpeg8-dev libpng12-dev
```

Your **git** command created a directory, so move into it and start the compile. This is not a very big or complex compile, but look out for faults.

```
$ cd omxiv
```

The first make command creates all object files.

```
$ make ilclient
```

The second command creates the binaries.

```
$ make
```

The third moves the binaries on your system.

```
$ sudo make install
```

Thanks to the split of the parts of the compiler, you can compile on a different computer than the one you're going to run it on. This is called cross-compiling, if the machines have a different architecture. Keep this in mind if you want to compile more complex code for your tiny Raspberry Pi.

There's one more package to install: *omxplayer*. It's a command line player for media, and your remote will call it to run the media.

```
$ sudo apt install omxplayer
```

Now you have everything you need to run media on your Pi. Next is to make it possible to access it from a remote system. Before you can continue, you need to know how to access your Pi. The hostname command will give you the name to use. Check your hostname.

```
$ hostname
```

Looking up the hostname sometimes causes problems because it needs to be fully qualified. This means that it contains the top-level domain (.com). So, just in case, print the IP address.

```
$ ip a
```

The printout will have the **localhost** address and the other one that you want in the printout. Now make sure that you've set the password to something more secure than the default, using **raspi-conf** or the **passwd** command. To use this, you need an app running on your mobile phone: *RaspiCast*.

Install *RaspiCast* on your Android phone. Yes, the *RaspiCast* is actually the client calling the Pi. It serves the media and displays it on the screen connected to the Pi. Once you have it running, start it and fill in the form for casting. It's simply the hostname, username and password that you've set yourself. After you've logged in, you can pick the files you want to play or send your YouTube session to the Raspberry Pi.

QUICK TIP

Installing compile tools can be a hassle. Learn about how you can use Docker or NixOS to create a compile environment that doesn't mess up your main machine. Cmake exist as a Docker image here: **https://github.com/docker/buildx#binary-release**.

QUICK TIP

Look for OBS plug-ins for the specific stream you're planning. Many other content creators have come with neat little tricks to make life easier and shared them for you to use and enjoy.

Home automation

Most of the standards mentioned in this article are specifically for media of different kinds. However, a new market has emerged: home automation. Being able to connect to household devices such as your lights, heating system and even your fridge using W-Fi has become the norm.

Sensing new business opportunities, Apple and Google have gone their own way, creating two proprietary standards. This prompted Amazon to create its own standard, knowing that it couldn't compete with the big two. Amazon created Matter as an Open source project and an open standard. The standard will connect all media, entertainment and Internet of Things.

This project started as project CHIP (Connected Home over IP), but has now been renamed Matter. The story is long and involves many diverse efforts. The Zigbee alliance is part of the current group Matter, while the well-known Zwave is left out. The organisation handling this is the Connectivity Standards Alliance (**https://csa-iot.org**). Its mission is to join all standards together, making it easy to integrate many brands in your smart home.

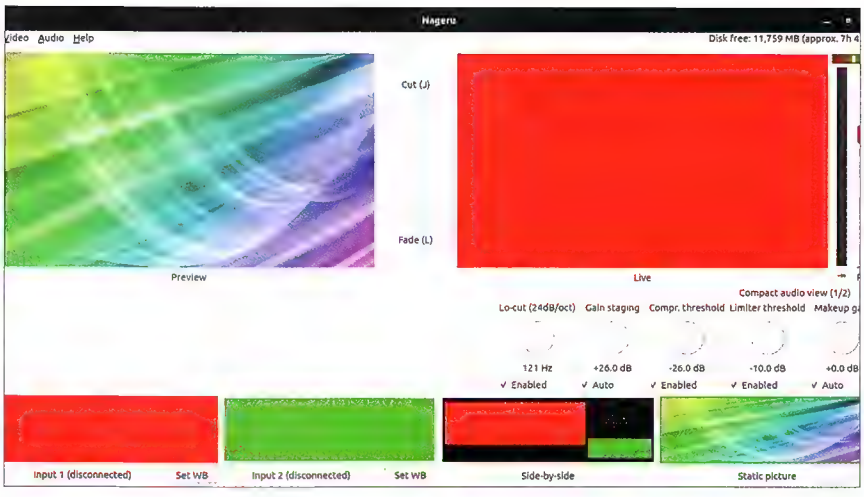
Until now, if you wanted to set a home automation system then you'd need to create an account with a cloud company. You would end up having all your house commands go over the internet, which isn't ideal. New competitors are coming on the market though, which can help you get started without constantly relying on an external supplier.

Future casts

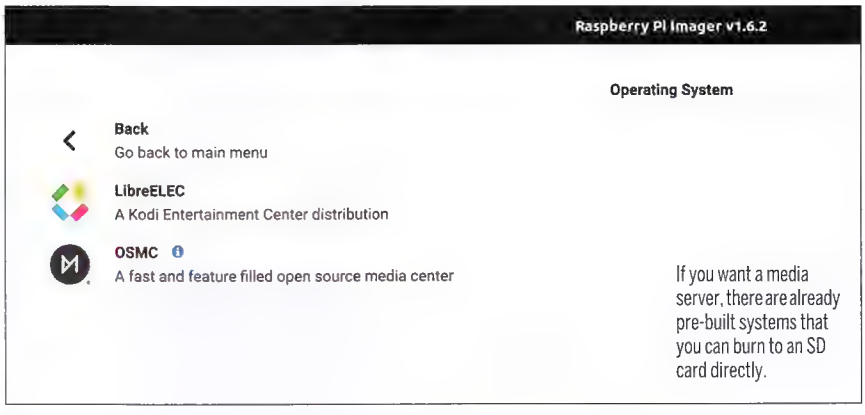
There are many angles to the streaming world that can keep you occupied, whether you're consuming or producing content – or both! Make sure you balance your activities. This way you challenge yourself and contribute in your own way. For streaming your own media, there's a vast array of hardware that make things easy for you. For more complex projects you'll have to use alpha software to make it work.

When you produce your own show, you will have a great partner in *OBS Studio*. Other solutions exist, so think twice about what you want to stream before you choose your solution. You could end up putting too much effort into a very simple task. Sharing the command line is much easier and lighter than making all video and transitions available. Look around before you decide which way you want to go.

At first glance, streaming is all about entertaining videos and helping others over the web, but when you look closer there are more functions to consider. Initially it was all about streaming over Wi-Fi without an access point, but now more use cases have come to light. Using the same standards in automating your home and controlling your power consumption and generation is the next step. ■


Nageru
Video Audio Help
Disk free: 11,759 MB (approx. 7h 4
Cut (J)
Fade (L)
Preview
Live
Compact audio view (1/2)
Lo-cut (24dB/oct) Gain staging Compr. threshold Limiter threshold Makeup g
121 Hz +26.0 dB -26.0 dB -10.0 dB +0.0 dB
✓ Enabled ✓ Auto ✓ Enabled ✓ Enabled ✓ Auto
Input 1 (disconnected) Set WB
Input 2 (disconnected) Set WB
Side-by-side
Static picture

For many video streams, Nageru is a project to combine the video streams into a complete broadcast. Note that it's still in the alpha stage of development.


Raspberry Pi Imager v1.6.2
Operating System
Back
Go back to main menu
LibreELEC
A Kodi Entertainment Center distribution
OSMC
A fast and feature filled open source media center
If you want a media server, there are already pre-built systems that you can burn to an SD card directly.

HOME ASSISTANT

For the past decade or so, many suppliers of automation hardware and software have entered the market. This has led to several standards that you can use to communicate with your devices. The most common are Zigbee and Zwave.

Zigbee and ZWave aren't compatible, so you must support both or only have half the gadgets in your home automation setup. With a solution that can support both out of the box, Home Assistant (**www.home-assistant.io**) can help you with your home automation project. They build and sell a small box that contains a Raspberry Pi Compute Module, and radio hardware to connect to other devices.

Setting up such a system is slightly more complicated than a regular system, but there is a large number of pre-prepared examples on their web site and GitHub. The snippets are known as Blueprints and they define what will trigger a new event and what should happen after that. You may have a light that you want to turn on when the motion sensor in a room is triggered. The rules for which device triggers what action are in the Blueprints that you either need to write or just tweak from existing ones.

With this system, you can keep all your data and logic inside your home. This is something that's uncommon among other products you can find on the market.

ELECTRONICS

Tech that changed Australia (and the world) – Part 1

As the world gears up to celebrate 75 years of the transistor later this year, Darren Yates looks back in this new series at how electronics changed the world and the leading role Australia played in its development, beginning with the thermionic valve.

While several scientists, including Joseph Swan and Thomas Edison, have claims on the invention of the incandescent light bulb, there's no doubt this magic lamp that produced clean, odourless light at the flick of a switch brought the world into the 'electric' age. But in 1906, U.S. scientist Lee De Forest added extra connections or 'electrodes' to the light bulb - he then found that a weak voltage applied to one electrode could control the flow of a much larger current through two others. This discovery, later dubbed the 'triode', launched the world into the 'electronic' age. Despite thermionic valves (or 'vacuum tubes' in the U.S.) having been superseded for more than 50 years, this 'hollow-state' technology brought Australia closer to the rest of the world, gave us television and arguably some of the world's greatest music.

Australia's first-generation start-ups

Valves had a transforming effect on another nascent technology – radio – and its potential to bridge the vast distances separating Australia from the rest of the world ensured the industry grew quickly.

Global awareness of radio (or 'wireless' as it was known) was further raised by the loss of the Titanic in 1912. Shock led to dismay that despite the promise of radio, many lives were lost. In the days that followed, the U.S. moved to regulate wireless transmissions with the Radio Act of 1912.

The following year, Amalgamated Wireless (Australasia) Ltd, better known as 'AWA', was born and by 1918, the first direct radio message sent from the U.K. to Australia was received in the northern Sydney suburb of Wahroonga at the home of Ernest Fisk, AWA's then-managing director. The 'Fisk Memorial', unveiled by former Prime Minister Billy Hughes in 1935, still stands on the corner of Stuart and Cleveland Streets in Wahroonga to commemorate the historic event.

The Vox AC30 valve-powered guitar combo amp, as used by the Beatles and Dave Grohl.

The sprawling Amalgamated Wireless Valve factory in Ashfield, Sydney during the 1930s.

However, nothing epitomised the high-spirited 1920s in Australia more than radio broadcasting. Radio station 2CM kicked things off in Australia in 1921, followed by many well-known stations in the mid-1920s still broadcasting today, including Sydney's 2BL, 2UE and 2GB. Radio was the smartphone of the 1920s and the growing demand for 'wireless sets' also spawned Australia's first technology start-ups. Names like Airzone, Astor, Healing, and Kriesler began manufacturing in Sydney and Melbourne, respectively, in the mid-1920s and despite the Great Depression of the 1930s, it's estimated that two-thirds of Australians either owned or had access to a radio by 1938.

But what Australia didn't make at scale in the 1920s was thermionic valves. AWA manufactured the first Australian-made valve in early-1921 and by 1927 produced four valve models, but Australia needed a dedicated valve manufacturer to handle demand for more types. That led to a joint venture between AWA

As revolutionary as the transistor was when it was invented in 1947, it actually took the better part of 15 years or so for it to supersede the valve in consumer electronics.

and Radio Corporation of America (RCA) in 1932, forming the Amalgamated Wireless Valve Company (AWV). AWV not only licensed the patents of tech giants RCA, Marconi and Telefunken to make U.S. and European valves, but also began research and design of new valve technology in Australia under the famous 'Radiotron' brand. The first of two AWV factories began production in Ashfield, Sydney in 1933, another in Rydalmere in Sydney's west began in 1956.

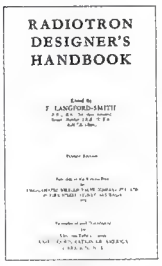
AWV was later joined in Australia by Dutch giant Philips, setting up a valve factory in Sydney in 1937 and producing high-quality Australian-made valves. During the 1930s, AWV valves were licensed and sold by the U.S.-based Kentucky Radio Corporation ('Ken-Rad') and by British General Electric via the 'Osram' label. Philips' Australian-made valves were branded 'Miniwatt' and later also sold under the famed 'Mullard' label - they are still highly sought after today. The 6M5 valve used in thousands of valve radios in the 1950s was designed and manufactured here in Australia.

Above: The Fisk Memorial commemorates the first radio message from Wales to Australia in 1918 (Source: Cabrils, CC BY-SA 4.0).
Above right: Valves made possible everything from radio to radar, television to first-gen computers.

Knowledge Exports

But valves weren't the only technology export we had to offer. COVID notwithstanding, Australia today has a growing knowledge economy, with places at our universities favoured by overseas students. As a leader in valve research, Australia was also an exporter of technical knowledge.

First published in 1934, the *Radiotron Designer's Handbook* was (and still is) considered the 'valve bible' for electrical engineers the world over. By the time of its final-revised fourth edition in 1967, it topped 1,500 pages. It was edited by Australian electrical engineer Fritz Langford-Smith, who trained at the University of Sydney, in collaboration with a dedicated team of AWV engineers. The 'big red book', as it was known, was published by AWV in Australia and RCA in the U.S. This fourth and last edition is now available free online at **http://www.tubebooks.org/books/rdh4.pdf**.



The Radiotron Designer's Handbook, Australia's gift to the tech world since 1935.

'Welcome to television'

If it hadn't have been for World War II, it's very likely Australia would have had television during the 1940s, rather than its eventual start in 1956. Television was already popular in England before war broke out in 1939 and TV broadcasting launched in the U.S. in 1941. In fact, AWV began producing valves designed for TV sets as early as January 1939. It wouldn't be until after the war that the first local electronic television demonstrations in 1949 and 1950 gave Australia a glimpse of the future.

In the end, the 1956 Summer Olympics in Melbourne became the catalyst for the introduction of television in Australia, with Nine Network station TCN9 in Sydney's Willoughby broadcasting first in September, followed by Melbourne's GTV9, HSV7, the ABC's ABN2 at Gore Hill in Sydney's north and ABV2 in Melbourne all transmitting before the Olympics in November of that year.

Again, the long pent-up demand for television also saw Philips and AWV manufacturing television picture tubes in Australia by 1956. There's a fascinating 20-minute YouTube video on the manufacture process and the skilled men and women in the AWV Rydalmere factory. Search YouTube for 'Amalgamated Wireless Sydney'.

Valves still rock today

As revolutionary as the transistor was when it was invented in 1947, it actually took the better part of 15 years or so for it to supersede the valve in consumer electronics. Yet, valves are still being made today (although not in Australia) and are highly prized by some of the world's top musicians, including Mark Knopfler, David Gilmour and Dave Grohl. It's said that starting from their third album, 'There is Nothing Left to Lose', all Foo Fighters albums since feature Dave Grohl playing through a Vox AC30 valve guitar amplifier (the same amp type used by the Beatles some 60 years ago).

Next time, we look at the role valves played in World War II, from Australia's tech industry re-tooling for the war effort to learning about the Australian scientist involved in the development of the cavity magnetron. ■

The Tandy TRS-80 may have had a cheap and nasty keyboard, but that classic silver case was just so darned cool!

You'll need this
A copy of VCC
Downloads are provided on the project's GitHub page. Extra system ROMs not required.
https://github.com/VCCE/VCC/releases

MACHINE OF THE MONTH

Tandy TRS-80 Color Computer (1980)

John Knight adds some colour to the TRS-80's history.

This month we explore a true American classic: the TRS-80 Colour Computer, otherwise known as "CoCo" for short. Not to be confused with the original TRS-80 manufactured in the late 1970s, the CoCo was to be a new system for the 1980s, designed to take on Apple and Commodore with something more affordable, and in colour no less.

The CoCo provides a sizeable library for any 8-bit enthusiasts. Unfortunately, running this software can be a tricky process, so we will guide you through the steps needed to emulate this groundbreaking machine.

Development and release

The CoCo began life as a VideoTex terminal designed to provide farmers with access to real-time agricultural information. The VideoTex terminal used Motorola's Video Display Generator (VDG) chip and 6809 processor. Although the VideoTex was commercially unsuccessful, in 1980, it was combined with newer hardware to form the basis of a new colour computer.

Tandy removed the VideoTex's internal modem and added expansion for ROM cartridges, cassette input, serial I/O, and joystick ports. Video output was based around a standard TV set.

The first TRS-80 Color Computer launched in September 1980. Although the base model was quite cheap, the system relied heavily on expensive peripherals and users even had to supply their own tape drive.

Specifications
CPU: Motorola 6809E @ 0.895 / 1.79MHz **RAM:** 4KB–64KB, 128KB–512KB **Graphics:** Motorola 6847 VDG, 256x192 maximum resolution, 9 maximum colours **Sound:** 6-bit DAC **Storage:** ROM cartridge, cassette, 5.25-inch floppy **OS:** Color BASIC, Extended Color BASIC, OS-9 **Released:** September 1980 **Production:** 1980-1990, 1991.

Despite its name, the CoCo shares nothing in common with the original TRS-80 and is not backward compatible.

The CPU is a Motorola 6809E clocked at 0.895MHz. Sound is basic, being handled by a single-channel 6-bit DAC, powered by the CPU. Graphically impressive for the time, the CoCo is capable of nine colours and a maximum resolution of 256x192.

The base specs provided 4KB of RAM and Colour BASIC, a Tandy implementation of Microsoft BASIC, in an 8KB ROM.

Models with 16KB (and later 32KB) of RAM were also available, with the option of Extended Color BASIC.

Software

The CoCo software library has a different emphasis from many systems. It featured better educational software than Commodore's machines, though its limited 32-column text mode meant the machine wasn't suited to business applications.

For anyone looking to get into BASIC programming, the CoCo is an excellent place to start. There are plenty of books and magazine listings, and Tandy's own 'Getting Started With Color BASIC' manual was considered one of the best in the business.

For some gaming highlights, *Dungeons of Daggorath* (1982) is a particularly famous first-person dungeon crawler, with real-time gameplay and unique line graphics. *Skiing* (1980) is a personal favourite – its first-person 3D perspective is surprisingly effective, despite the machine's graphical limitations. *Zaxxon* (1983) is a solid port and one of the system's better titles.

Other games included *Time Bandit* (1983), *Speed Racer* (1984), and *Pitfall 2* (1985), which is a great update on a classic. For titles that push the system harder, check out *Thexder* (1987), *Springster* (1987), *King's Quest III* (1988), and *Rampage* (1989).

Most software titles and reference manuals can be found at the excellent **colorcomputerarchive.com** website.

Legacy

In 1983, the CoCo was upgraded to the Color Computer 2. These new models brought drastic price reductions and featured either 16 or 64KB of RAM.

The case was re-designed: consolidated chipsets allowed for a smaller footprint, and the iconic silver styling was replaced by beige. Later models, named the Tandy Color Computer 2, featured full-travel keyboards.

TROUBLESHOOTING

If your programs load in black and white, you can change to colour by pressing F6. Or you can open VCC's Options window, select the Display tab, and choose Composite instead of RGB. If you want to use a joystick, you might consider an old-fashioned flight-sim joystick with analog controls. The original Tandy joysticks were nasty devices that used analog positioning and didn't auto-center.

In some games, a modern controller may result in large jumps across the screen, even when using an analog thumbstick. It may be awkward, but you might consider using the mouse for certain titles.

In 1986, the Color Computer 3 pushed CoCo architecture to its limits. A newer variant of the 6809 CPU allowed for twice the clockspeed and the CoCo came with 128KB as standard, upgradeable to 512KB.

The Advanced Color Video Chip allowed features such as memory bank switching, RGB output, 80 column text, 16 colours on screen from a palette of 64, and resolutions up to 640x192. Extra keyboard buttons were added, cursor keys were grouped in a more conventional layout, and more priority was given to Microware's OS-9.

In October 1990, Tandy discontinued the line, though stores continued to sell CoCo stock. As for how many they sold, Tandy was notoriously tight-lipped on figures.

Emulation

The easiest emulator is VCC, which emulates the CoCo 3, but its interface can be obtuse. VCC only supports Windows, but Linux users can run VCC through Wine or OVCC. Still, it can be a pain to install. You can try MAME, though you will need system ROMs.

The VCC's Github page provides a self-extracting Windows executable, with a simple installer interface that will automatically create entries in your system menu.

Once you open the application, we recommend switching VCC's keyboard layout to a modern PC key mapping, otherwise entering BASIC commands will be a nightmare.

From the main menu, choose Configuration > Config. In the new Options window, open the Keyboard tab, and in the Select Keyboard Mapping field, click Natural. There, it's worth opening the Joysticks tab to define how you will control your games.

Loading cartridges

Unlike the other storage mediums, loading cartridges is easy. Just choose Cartridge > Cartridge > Load Cart.

Select your cartridge image from the file browser, and the emulator will reset, loading the cartridge automatically.

Loading tapes

Loading tapes isn't difficult, but it is unintuitive. Open the Options window by selecting Configuration > Config, then open the Tape tab. Click Browse to open a cassette image file, then click Apply. It's worth keeping the Options window open and moving it to one side because you'll need to use it again.

Click on the main window, and in the BASIC prompt, enter:

```
CLOADM
```

The emulated Tandy will now wait for you to press Play on the tape recorder – in the Options window. Press Play and the BASIC prompt will flash an F character to indicate the program is loading. Once finished, the prompt says "OK", and has a blinking cursor.

To run the program, enter:

```
EXEC
```

Loading disks

When it comes to loading disks, VCC's method is bonkers. This also requires BASIC commands.

On the original CoCo, disk drives connected via a cartridge interface, so VCC does something similar. When you first start VCC, there will be no apparent way to load disks. But if you load a cartridge, the file browser opens in VCC's installation folder, with the file fd502.dll.

When you open the Cartridge menu, there will be a series of floppy drive sub-menus called FD-502. Load a disk in the first drive by clicking Cartridge > FD-502 Drive 0 > Insert. Select your file and you'll be taken back to the emulator screen.

To load a program, browse the disk and look for the filename. Browse the first floppy drive by entering:

```
DIR 0
```

In the output that follows, look for either BAS (basic programs) or BIN (binary programs) files. If there are any BASIC programs, try loading these first.

To load a BASIC program, enter the command:

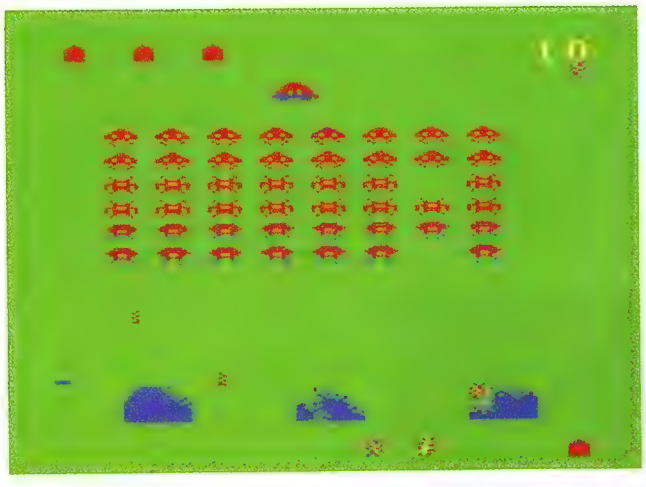
```
RUN "0:BOOT.BAS"
```

We used BOOT.BAS as an example, but replace this filename with whatever you have on your disk image.

If there are no BASIC programs, run a binary program by entering (using Zaxxon as an example):

```
LOADM "0:ZAXXON.BIN" : EXEC
```

■



CoCo games have a strange colour palette. *Color Space Invaders* (1981) has a green background instead of black.

Games such as *Rampage* (1989) for the CoCo 3 are more sophisticated and benefit from its two-button fire mode.

Photo mode makes shots like this possible.

$TBA | PC, PS4/5, XB1/S/X | playwonderlands.com

Tiny Tina's Wonderlands

Still very much a *Borderlands* game.

While it looks like a bouncy fantasy-comedy, *Tiny Tina's Wonderlands* plays like *Borderlands*. Specifically, *Borderlands 3*. Some of the guns shoot crossbow bolts and the grenades have been replaced by spells, but moment-to-moment it's typical *Borderlands* – you shoot hordes of bad guys who repeat pithy one-liners, then compare loot to see if the new guns and shields are better than the old ones, and then do it again.

I spent most of my time as a Spore Warden, a kind of fungal ranger with a walking mushroom pet I upgraded so he farted poison. A few of the classes get NPC allies; my co-op buddy played a Graveborn who had a floating skull friend. My mushroom companion really came into his own when I played solo, even able to revive me when I dropped in the absence of a co-op partner. While co-op is a chaotic good time like always, having an NPC ally makes playing alone an even more viable option, and it was already a totally satisfying way to play.

The Spellshot's class ability, being able to slot in two spells rather than one, seemed underwhelming at first, but when you get spells that drop ice meteors on skeletons – who take bonus frost damage because they don't have skin to keep them warm, just go with it – it seems worth it. But the Stabbomancer being able to throw a spinning melee weapon that becomes a blade tornado you can reposition around the battlefield? That's my current fave.

Melee weapons are a new addition, but not a game-changing one. Your regular melee attack, still mapped to V for some reason, becomes a whack with whatever sword, axe, or stick you've picked up. They've got randomised stats, though nothing as wild as the guns. Same with armour, which mostly boosts your class abilities like relics do in the mainline *Borderlands* games, rather than providing any actual protection.

Like previous *Borderlands* games, you'll want to push the FoV up and the look sensitivity down. Weirdly, the hotspot for the left arrow on every menu slider is slightly off. You can click on the right arrows fine, but have to click sort of near but not actually on the left arrows.

It's funnier than *Borderlands 3*, that's for sure. It helps that Will Arnett, as the Dragon Lord, makes an amusing villain. Because of course he does: He's Will Arnett. Smug monologuing is his entire thing, and if he never quite equals Handsome Jack from *Borderlands 2* that's only because nobody will.

It still succeeds more often than it fails, though. That's partly just because of how the *Borderlands* formula has been honed over the years.

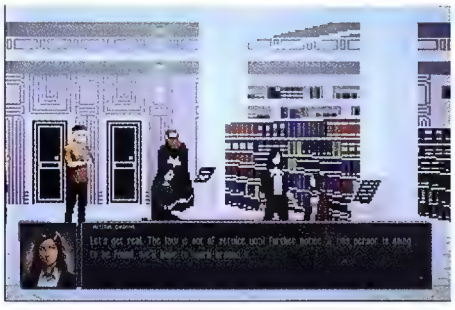
Below left: Legolas upgraded his bow. **Below:** Brick returns as the Fairy Punchfather.

Tiny Tina's Wonderlands is better than *Borderlands 3*, but doesn't quite reach the heights of *Borderlands 2*.

Jody Macgregor

★★★½☆

PIERRE DANTON
Goddamn fucking unions shits. I knew they'd take out their inadequacies on me.
BANK ACCOUNT 24,016
MISSION LOG



\$35.95 | PC, XB1/S/X, Switch, Mac | generalinteractive.co

Chinatown Detective Agency

Get ready to Google your own clues.

In 2037, Singapore has gone through the unthinkable process of deregulation, there's anti-government graffiti on the train, droids are a routine sight, and there's only one human librarian left in the country. You play as Amira Darma, an ex-cop starting out as a private investigator. As she takes on cases and meets clients, Amira gets to travel the world while pulling at the threads of a much bigger mystery.

Most cases take you to different cities – Amira uses a travel program called HORUS to plan flights. Eventually she must choose a main client – I went with Tiger Lily, who runs a "health club" in the red-light district of Geylang. Her case involves a local megachurch and the dysfunctional family behind it.

The puzzles are probably the most divisive part of the game. CDA's main thing is Googling clues yourself – there's a UI button to tab you out into a browser. Even as someone who loves ciphers, a couple of puzzles were overly tiresome. There's a fine line between giving the player a sense of satisfaction while still pushing them to break a little sweat, and here CDA wavers. Thankfully the game offers help, so it's really up to how much of a masochist you are.

Small inconsistencies made for an occasionally frustrating playthrough. The initial part of the game auto-saves after each case. You're supposed to be able to save at your own discretion after you've chosen a main client, but this feature only worked for a short time.

The writing is a little uneven – the main cast is fairly well-characterised, but a few segments of heavy-handed exposition veer into overly theatrical territory. Most NPCs had one or two canned lines of dialogue that occasionally included mildly jarring non-sequiturs, but is consistent with the idiosyncratic nature of point-and-click adventures as extensions of the developers' personalities.

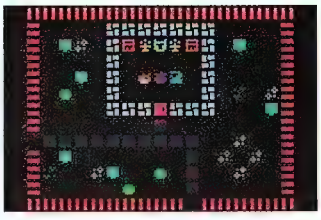
I could leave the generic main plot, but as far as point-and-click adventures go, it's a pretty good debut.

Chinatown Detective Agency is a pretty solid detective adventure with a unique DIY approach to clue-solving.

Alexis Ong

★★★½☆

Top: The game taps into ongoing discourse around labour rights.
Above left: In the future, the law is on vacation.
Above: No, you can't pet the dog in the Great Abode.



Free | PC, Mac
dotmoon.itch.io/frog-familiar

FROG FAMILIAR

Will it put a spell on you?

In this top-down adventure game, you play as a witch's amphibian familiar, who has to hop around a compact forest in search of ingredients. Imagine *The Legend of Zelda*, but un-imagine the combat and dungeons, and you'll know what you're in store for: a game of exploration and running errands for the charming folks of the forest.

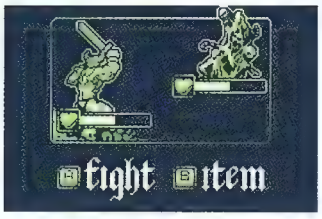
Your main quest, and it's a fairly low-stakes one, is to gather various bits from around the low-res environment. We're talking mushrooms, herbs, bones, and a magic crystal, if you can find one.

I completed the game almost without realising it, by which I mean I found everything, grabbing every item and wrapping up every quest. *Frog Familiar*'s world feels almost as intricate as one of the early *Zelda* games, but it achieves this in miniature. Over the course of about an hour, you'll go from a humble, hoppy frog to being at one with the forest, via a bunch of tools that will unlock pathways and let you hoover up every last collectable item.

A cosy, *Zelda*-esque adventure that's no less satisfying for being a fraction of the size.

Tom Sykes

★★★★☆



Free | PC | bit.ly/traumatarium

TRAUMATARIUM

Boy is this a good game.

Here's a roguelike made for ye olde original Game Boy – as in, you can download the ROM and play it on the actual hardware. You can also play it in your browser, delving into the dungeon to save an imperilled fantasy kingdom.

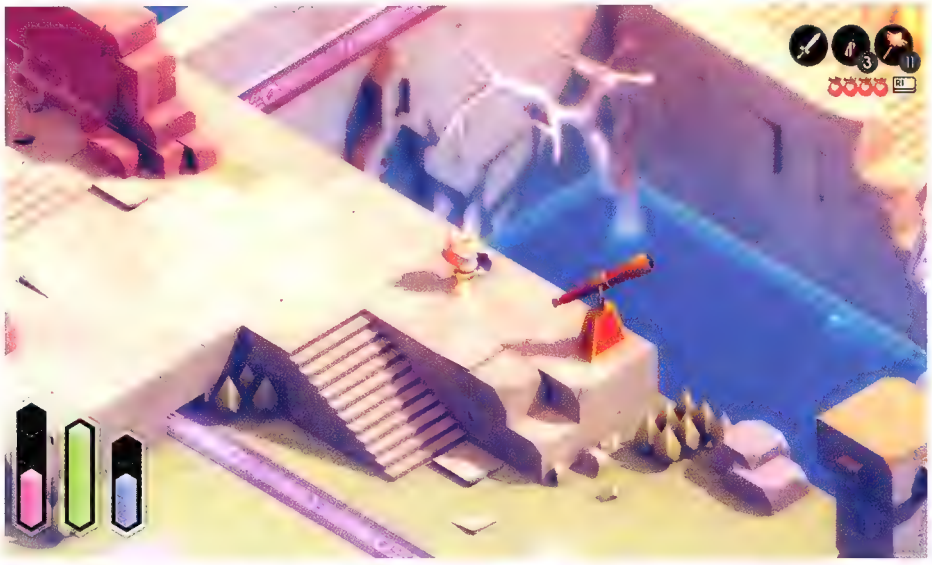
Traumatarium is a pretty simple game. The world is constructed as a series of rooms presented in a random sequence, with randomised events occurring as you search each room. You're linearly shunted along, before you face the end game boss. It's a game of taking, or avoiding, calculated risks. Winning the turn-based battles grants experience, but in doing so you'll chew through items to recover your health. Should you try to avoid combat, and hoard your medicine for the upcoming boss instead? It's an engaging enough system, although I found that boss to be a pushover that I defeated easily on my first time through.

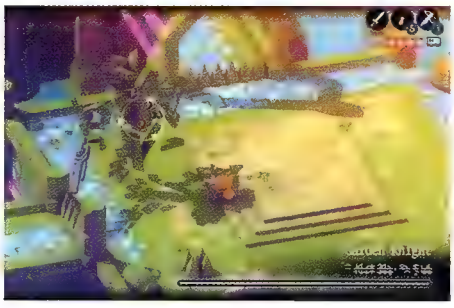
Still, I was inspired to play the game again, where I was rewarded with a notably different-feeling dungeon.

A striking roguelike that is worth a play.

Tom Sykes

★★★☆☆





apc EDITOR'S CHOICE

$42.95 | PC, XB1/S/X, Mac | tunicgame.com

Tunic

Adorable and gorgeous – but it's got teeth.

Top: Telescopes give you a better view of your surroundings. **Above:** Bosses will put your skills and patience to the test. **Above right:** These statues provide a safe haven, but also respawn enemies.

Beware of *Tunic*'s cute exterior. On the surface, its lovely art style and charming tone bear a striking resemblance to Nintendo's *Zelda* series. But below this cheery surface lies a game intent on testing your resolve. *Tunic*'s world is teeming with enemies who are all too willing to knock the stuffing out of you. And you'd best be prepared to die – it has as much in common with *Dark Souls* as it does any of Link's previous outings.

After an abrupt opening that sees our fox friend wash up on a beach, there's little in the way of storytelling. And what scant plot *Tunic* does have is purposefully vague. This world's wider mystery is a nice addition rather than a compelling reason to play, as just exploring its fascinating surroundings, doing battle with its unsavoury inhabitants, and uncovering its many layers is a riveting story all of its own.

This beautifully constructed isometric world is nothing short of joyous to explore. Both the overworld and the game's many dungeons offer intricately designed environmental puzzles. A lot of the game's locations can be explored straight off the beach, but either difficulty or a lack of equipment usually prevents you from deviating too far from the intended path. Enemies don't go easy you just because you're adorable. They are more than willing to kick your puffy tail right back to the last checkpoint. The highlight is the boss battles. Every encounter is a spectacle, although you won't have much time to appreciate the artistry as you dodge slam attacks and flee from devastating lasers. The highlight is the boss battles. Every encounter is a spectacle, although you won't have much time to appreciate the artistry as you dodge slam attacks and flee from devastating lasers.

While it draws inspiration from some of gaming's greats, *Tunic* has a unique sense of wonder. Its visuals and focus on fun make for a captivating experience. At the same time, the contrasting challenge it presents adds an extra level of satisfaction that make it an adventure you won't soon forget.

Delightfully difficult combat and meaningful exploration make *Tunic* a retro-inspired modern masterpiece.

Anne-Marie Coyle

★★★★½

apc EDITOR'S CHOICE

$21.50 | PC, Mac | norcogame.com

Norco

A landmark moment for point-and-click adventures.

When people talk about *Norco*, they might mention its discerning use of science fiction, its punk roots, or how it resonates as a universal story about place and personhood. It's full of social commentary on capitalism in the real-life Louisianan town of the same name. But for all these lofty themes, it also nails something petty: the tiny weaknesses and hypocrisies of people looking for a place to belong.

The story follows Kay, a young woman who returns home to Norco to find her brother, Blake, in the wake of their mother's death. As something of a nomad, she's been running from her roots in a post-apocalyptic America marked by homegrown militias, gentrification, and fraying infrastructure. The player switches between Kay and her mother Catherine – not long before her death – as they get pulled into a surreal, tech-noir mystery. With its intense examinations of present-day problems, including a darkly funny look at the moving parts of the average gig economy job, *Norco* is at once somber and bitingly funny.

Norco has a full-throated commitment to its story. To this end, each character in its ensemble cast has a well-formed persona – at least to the best extent that their allotted screen time allows. Every prickly drug dealer, partygoer, and Airbnb guest are scathing caricatures of the modern social scene, brought to life by the dialogue. Private investigator Brett LeBlanc is a particular treasure, as well as Catherine's friend Keith – LeBlanc especially is a neat character study into the value of unexpected community ties and found family.

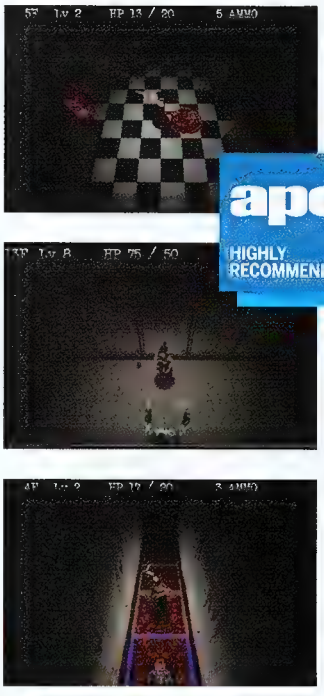
Norco is a bastion of evocative storytelling that invites any player to take refuge in its world. But, it cuts deep as a sobering, but loving portrait of a modern dystopia – a community on the edge of great change. There are few games in the world like *Norco*, and it belongs unequivocally in the highest tier of narrative experiences in the medium today.

A must for anyone interested in narrative-driven games – nuanced, fascinating, and full of personality.

Alexis Ong

★★★★½

Top: New Orleans' most iconic tourist location: the French Quarter.
Above left: Hell hath no fury like disturbed Airbnb guests.
Above: One of many lavish soirees in the heart of the Shield Oil Refinery.



apc HIGHLY RECOMMENDED

Free | PC, Linux
bit.ly/HouseNecrosis

HOUSE OF NECROSIS

An itchy, tasty horror roguelike.

Some PlayStation-style games are convincing, while others feel like modern games with a couple of filters applied. Happily, *House of Necrosis* is the former. It's a traditional, turn-based roguelike mixed with a gory survival horror.

As in most traditional roguelikes, positioning is hugely important, as you close the gap between you and your enemies. If you move next to the enemy, you can hit them with your melee weapon, but they'll get an attack in return. This can really gouge your health bar, although there are ways to mitigate it. Firstly, you can shoot them from afar, using your pistol and its limited ammo. You can also level up in power, by deliberately seeking out enemies.

There is a bit of procedural shenanigans. One run was bountiful with ammo, while others have been stingier. Sometimes you'll spawn in a room teeming with enemies. But on the whole I feel it's fair. It's only on the later floors that you wonder whether you should have killed them for the experience points.

A simple yet tactically compelling roguelike, with a grungy horror aesthetic.

Tom Sykes

★★★★☆

GAME CHANGER

Binary Domain

Matt Elliott has wasted years not shooting robots.

RELEASE April, 2012 **DEVELOPER** Devil's Details **PUBLISHER** Sega **LINK** sega.com

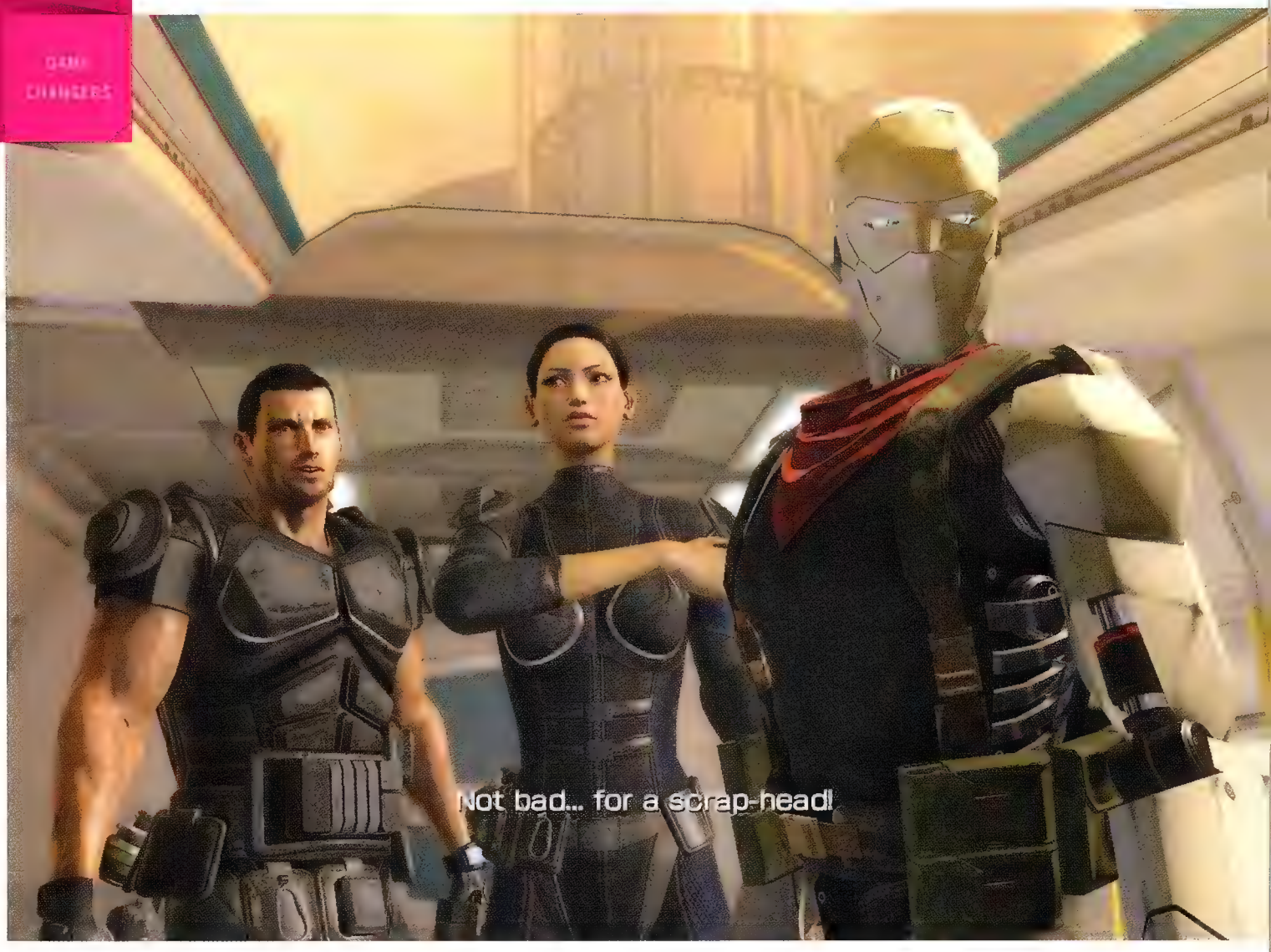
Have you heard of Sisyphus? I bet you have. He's the lad from Greek mythology who twice cheated death, so Zeus, king of the gods and occasional horny swan, cursed him to repeatedly roll a big rock up a hill for all eternity. Every time he reached the top, down the rock would roll back down and Sisyphus would start again. Which is bad. But what if, let's suppose, Sisyphus secretly loved rolling rocks? What if rolling rocks up hills, however repetitive, was as fun as shooting robots in *Binary Domain*? What then, Zeus?

It's perhaps not a question that's troubled classical scholars, but it's relevant here. Because my memory of *Binary Domain* is vague and hallucinatory, like something from a Michel Gondry music video. I recall a game that scored 70 percent, lost 5 points for repetition and another 10 for shitty boss battles, then clawed 20 back in hindsight for being a laughable cult classic. But I remembered it wrongly. Actually, the rock-rolling element of *Binary Domain* is simply magnificent. If Zeus cursed me to shoot olive robots in neo-Tokyo for the rest of time, only for a fresh dropship of enemies to arrive at the end of every level, I'd pretend to be sad so he didn't find a more upsetting punishment.

The base game of *Binary Domain* is deeply satisfying – a burly, competent cover shooter with an infectious central gameplay loop. It's wonderful seeing glittering shards of scrap metal going flying off your robot foes. Most standard enemies are the right kind of slow and stupid, just agile enough to make you feel good about yourself when you explode their shiny metal heads. It makes me realise the only thing wrong with *Binary Domain* is that it tries to do too much, fussing and fluffing like an anxious vicar about to meet the head of the Women's Institute. But instead of offering an unnecessary proliferation of iced buns, *Binary Domain* insists on execrable boss battles and broken squad comms.

Turrets Syndrome

It's like a TV Tropes page for third-person shooters. It's not enough that there are turret sections; they have to happen during boss battles and also incorporate a tedious reloading mechanic *and* blundering NPC interaction. There's a bit where you have to fight poison gas and security droids in a futuristic cannabis farm, shooting shit you can't see while your suffocating teammate shouts at you. You even get to ride a Jetski out of a sewer, like *Terminator* and *Police Academy 3* had sex and made a setpiece. There's far more variety here than I'd ever trust my brain to accurately remember. I would never have believed, for example,

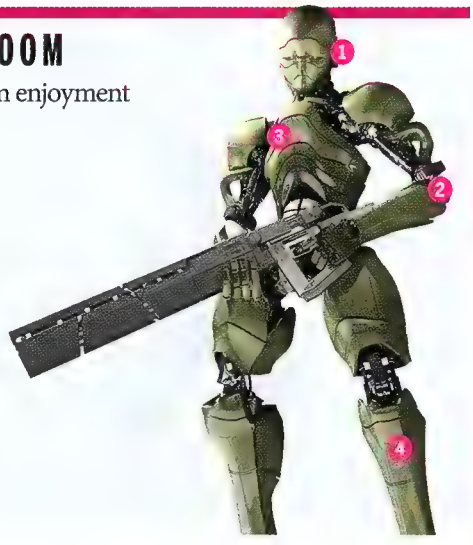


there was a bit where my team trundled around a car factory in little pods, like armed revellers in an unfurnished ghost train, but there it is. The problem is that most of these diversions are less fun than charging forward into cover and shredding metal enemies with a machine gun, but on occasion it bangs. The section on an elevated monorail is exhilarating, even if it is just a fast corridor with windows.

I also have a special place in my heart for the cast of *Binary Domain*. Protagonist Dan Marshall is one of gaming's great dickheads. Controlling him is like playing as a Kevlar fistbump – a no-hands wheelie of a man whose favourite phrase is 'holler if you're dead'. You get to carve out some of his personality via custom responses to your team's questions, but answering with anything even vaguely polite seems like a betrayal.

ROBOTIC-TIC BOOM

Aim here for maximum enjoyment



1 HEAD
Shatter a robot's face, exposing the Terminator-like visage beneath.

2 ARM
Blast his arms off and he's not going to be shooting you back any time soon.

3 BODY
It ain't elegant, but enough shots to centre mass will blast him into scrap.

4 LEGS
There's something so satisfying about sniping out a limb so they have to crawl.

But Dan seems positively nuanced compared to the rest of the team. We have Cain, a French robot who sounds like Poirot trapped in next door's dustbin; and Commander Charles Gregory, a character who's 70 percent posh British first names and 30 percent romantic lead from a Netflix Christmas film. Elsewhere there's a short-haired demolitions expert Rachel, whose character type is 'the one you're not supposed to fancy', except I do; and Big Bo, a crayon drawing of an African American who's like someone gave an ice-cream truck guns and taught it how to party.

Faye Accompli

Any attempt to add depth to the characters in *Binary Domain* is slightly undermined by the limited trust system. You build rapport with teammates by killing enemies with them and saving them when they're downed, but there's a conversational element, too. It's fun, even if your options are mostly limited to 'yes', 'no', and 'dammit', and you mostly win points for agreeing with everything they say. Yes,

Above: I've christened the one on the left 'Judy Hench'.

Right: True love is shooting a flying top hat.

inequality is bad. No, we shouldn't start shooting up the coffee shop. There's even a bit where you get universal approval from your team by not agreeing to romance a 15-year-old girl, which seems like rather a low bar, even for a throbbing gonad like Dan Marshall. It's clumsy, but it does add some welcome texture.

There's also some interesting stuff with Faye, an impeccable sniper from the Chinese People's Liberation Army, who also acts as a love interest for Dan. The story goes to some unexpected places, asking questions about machine intelligence and what it means to be human, but it ends up feeling like the cup noodle version of a Kojima cutscene. Deep existential questions are avoided in favour of romance. Choices are made because Dan fancies someone, not because he's reevaluating the fine line between sentience and AI. And honestly, I'm sort of fine with it. It feels like a very *Binary Domain* way to deal with debates about transhumanism.

There are some bits that simply don't work. For whatever reason, I couldn't get voice commands to function, so my first forays into the game were amazingly awkward. Bo would ask me a simple question and we'd have an excruciating pregnant pause while he waited for an answer. Yes, Bo, we *should* shoot the robots. In the end I had to turn voice commands off completely, but not before I got to try the calibration tool, which deserves a mention just because the choice of words – shit, damnit, shitdamnit – is telling. Pad integration, if you chose to live that way, is shaky, too: onscreen prompts are still mapped to the keyboard, which adds an unwelcome layer of danger when it comes to in-game conversation. I managed to press the wrong button after a romantic cutscene with Faye and called her an idiot, which felt like too much of a jerk move even for Dan.

Other wrinkles are more frustrating. There are moments when you're peppered by missiles from unseen enemies. Squadmates strafe into your line of fire then complain about it. And, on occasion, ammo can be frustratingly scarce, which feels like a terrible sin for a game with shooting this gleeful. The signposting is also terrible. It eschews in-game highlights in favour of dragging camera focus, which simply doesn't work. It's vague and frustrating, yanking your attention away from the action like a violent toddler holding hair straighteners.

But despite all this, I absolutely forgive *Binary Domain*. I love its lunkheaded, clumsy honesty. I love the crisp, metallic cleanness that you only seem to get with games from the early 2010s, like a shiny, favourite shirt that's been ironed too many times. And, in fact, maybe I'm looking at it the wrong way. The misguided diversions that stop me doing the thing I adore – basically destroying green robots until my PC becomes obsolete – actually make those bits more appealing.

Perhaps there's an alternate version of *Binary Domain* where I don't have to fight a robot gorilla too many times or get chased by electric spiders, and it actually makes me love the shooting less. The lesson here? Maybe all Sisyphus needed to appreciate his eternal punishment was a day spent rolling lots of different, smaller, more annoying rocks up the same hill. ■

BLAST FROM THE PAST:

WHAT'S NEXT FOR THE ZX SPECTRUM NEXT?

The ZX Spectrum Next is a modern-day version of Sinclair's classic computer. David Crookes finds out about the future plans for the machine.

The ZX Spectrum Next (**specnext.com**) is on a roll. As the modern-day version of Sinclair's ZX Spectrum – a computer celebrating its 40th anniversary this year – it has caught the imagination of retro enthusiasts who are not only enjoying the nostalgia of it all but also the growing number of games and apps being released for the system.

The stats are impressive. "We're currently tracking around 110 games and apps and around 60 percent of them are done and available, which is significant," said the project's main driver, Henrique Olifiers, co-founder of game maker Bossa Studio. "We have also heard of developers being able to ship more than 5,000 units of their software for the Next. That's twice what we ever expected."

With so much going on, it's no surprise to hear that thousands of people are waiting to get in on the action. But therein lies a problem. The ZX Spectrum Next initially got off the ground courtesy of 3,113 Kickstarter backers pledging a total of $1,247,000 in 2017. By February 2020, they had the machine in their hands and quickly got properly stuck in.

A further 5,236 people stumped up $3,185,000 for a second production run in August 2020, along with 594 people who bought direct, and they're still waiting for a delivery about 18 months on. It's a situation that has frustrated Olifiers, but one that a lot of manufacturers can sympathise with.

"The first campaign was a spectacular success and people were happy with what we delivered," he said. "Then we went full-guns blazing to the second campaign and got stung by Covid-19 and a shortage of parts. Every single electronics part has been difficult to find and we ended up in a situation where we had secured everything except for the FPGA cores."

The first-run ZX Spectrum Next included a $10 Spartan-6 FPGA, a chip Olifiers says has proven to be hugely reliable. When it transpired that these chips weren't going to be shipped in time for the second run, it caused great alarm among the Next

Baggers In Space uses the Next's advanced video modes.

The first ZX Spectrum Next run contained the Spartan-6 chip.

team. "There was no word on the horizon about when they were going to be made available again," Olifiers said. In the end, there was no alternative but to look for a different chip – the Xilinx Artix-7 – but that has caused issues of its own.

"It's a more capable chip but it's bigger and more expensive," Olifiers explained. "We had to alter the design of the board but we're now in the process of creating the last prototypes before we enter production. We're also going to absorb the extra costs ourselves. We would never put that cost on the people who backed this project. That would be unfair."

Second burst

Rather than issue an identical computer to the one created for the first run, the Next team took the opportunity to make improvements. The debut machine had a Z80 processor on a FPGA that could be turbo-boosted to 7MHz and 14MHz. It had 1MB of RAM expandable to 2MB internally, hardware sprites, 256 colours, video output in RGB, VGA and HDMI, support for a mouse, tape-loading if required, and three AY-3-8912 audio chips.

It was a far cry from the original 1980s ZX Spectrum range of 8-bit computers, which boasted no more than 128KB of RAM (16KB on the original model), a Zilog Z80 CPU running at 3.5MHz and a palette of up to 16 colours, two of which were black. But those receiving the new Next Issue 2 will enjoy a faster processor, more memory and a high-resolution mode. "There's always room for improvement so that's the route we took," Olifiers said.

Such specifications are more than capable of running original ZX Spectrum software and, with more than 1,700 games alone, there are plenty of old titles to choose from. But what Olifiers really wants to see are people pushing the Next technology to the limit with new offerings that make use of the additional features. As delays continued, he became concerned that the development community could start to lose motivation.

"That hasn't happened yet, but we need to be careful," he said. "We shouldn't suffer any more delays but that could have an effect. From what I see, developers who engage in projects are overwhelmed by the positive results they are achieving but I know that the Next Issue 2 should be in the backers' hands by now and the fact that it's still being produced isn't helping."

To ensure there is ongoing backing, the Next team has been looking for new ways to support software development on the computer. "When we began the project, we manufactured boards at our own expense and sent them, for free, to as many developers as we could secure," Olifiers said. "The idea was that people would succeed and inspire others and the plan worked out." But with a user base now established and more people about to climb aboard, the team wants to keep the momentum going.

Emulate for success

It helps that the ZX Spectrum Next is an open-source project and that others can produce their own boards and emulated systems. Olifiers pointed to a board called N-Go, a perfect clone of the Issue 2 Next that sells for $430. "We don't know how many of these have been made but we know a lot are buying them."

Such additional developments explain how software for the Next can shift as many as 5,000 copies when there are currently fewer official machines in the wild.

You can buy physical copies of some ZX Spectrum titles on SD cards.

Indeed, there's also a ZX Spectrum Next core in the popular MiSTer gaming device that makes use of an FPGA chip, while one of the best Spectrum software emulators, ZesarUX, also features support for the Next. "It's why it's important for us to foster an audience so the development community can flourish," Olifiers explained.

How else to support them? "We're toying with the idea of giving developers a little bit of funding to be able to work on their ideas and we're thinking about a format that Next users can subscribe to," Olifiers answered. "Maybe users could decide every month where the fund goes, which projects should receive the fund to get going. In that sense, it's kind of a novel approach to funding games and one that we think is going to work well for retro developers on platforms such as this."

The proposal has already been put to the Next community, and by all accounts, it has gone down well. "Like everything we do, we take it to the community first," Olifiers said. "Then we start to mess around with the format, getting feedback and working out how we'd do due diligence, and how we'd decide which project gets funding.

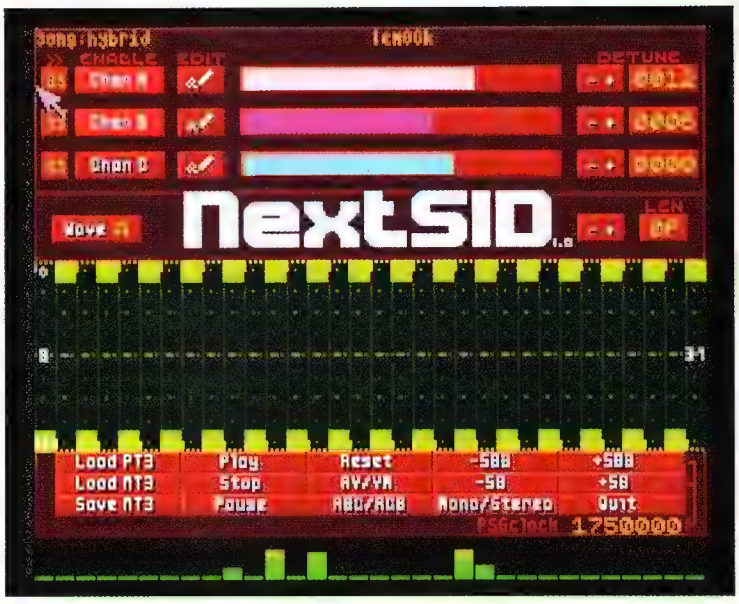
"I'd expect the pot to be substantial, allowing us to maybe allocate $8,000 to $15,000 each month. In the world of 'proper' game development and, certainly for large game developers, that is nothing. But for small projects on an 8-bit machine, and for a solo developer who needs to get started, that's a good sum. It's not a million but it's not nothing."

Big names on board

Some well-known developers are already involved in Next software development. Chief among them is Jim Bagley, an industry stalwart who developed games such as *Batman: The Caped Crusader*, *Cabal* and *Midnight Resistance* for the original ZX Spectrum.

Published by a specially created software house called Rusty Pixels and with a small support team, Bagley has worked on an unofficial port of *Tetris* called *Crowley: World Tour*, the reflex-reliant *Tyvarian* and a curious 2D platform adventure called *Baggers in Space*, which features Bagley himself as the lead character.

NextSID is an impressive free music player.



He's also developed an enhanced remake of the 1986 platformer *Warhawk* and a version of the Konami shooter *Scramble*. Bringing old games back to life by using the enhanced features of the Next is certainly proving popular, and Olifiers says he is fully supporting developers who want to go down that path.

"Some people want to revive old games like *The Way of the Exploding Fist*, *Head Over Heels* and so on, so we have been working to secure IPs like that from the original holders," he explained. "I'm actually super keen on seeing *The Way of the Exploding Fist* as a Next game. It was one of my first games on the original Spectrum and the team behind it is doing a stellar job."

Henrique Olifiers with a ZX Spectrum Next circuit board.

Beyond gaming

Development is not concentrated entirely on gaming. February saw the release of a music player called NextSID that made full use of the Next's AY sound chips, and there's an app that allows the computer to connect to a database and directly download software. "That's super cool and the kind of project I want to see driving forward," Olifiers said. There's also a browser using the Gopher communication protocol, an alternative to the World Wide Web.

"The apps are coming," Olifiers confirmed. "We have music trackers, very good trackers along with apps for developing games such as text adventures. But I'm keen to see more apps with online functionalities and those that make use of the accelerator board for 3D graphics. I know of two projects being worked on with online multiplayer which I'm keen to see."

Even so, he knows the ZX Spectrum Next has its limits. Although he'd like to see someone attempt a web browser ("it won't be for the faint-hearted, I'm afraid, trying to decode JPEGs and PNGs on the Next in real-time – you'd have to use the accelerator"), nobody is expecting users to set their PCs aside in favour of an 8-bit computer.

"There are word processors out there but I would never expect someone to use the Next for work – unless work is being interested in learning how to create games and apps," he said. "For that purpose, the Next is ideal. It's very easy to create things with our computer and because the software,

operating system and hardware is exposed, it lets developers understand exactly what is going on in every aspect of the machine."

This is something he believes we've lost over the years. "When you're dealing with Windows or Linux or consoles, there are many degrees of separation, not least engines in the middle," he said. "So one goal of the Next is for users to learn how things work as a developer. From a productivity point of view like spreadsheets and so on, though? Well, it's not really meant for that."

On that score, Olifiers is keen to get more children involved with the Next. There is evidence of parents buying the computer for their kids in the hope they'll try their hand at coding, and he would like to see more apps and games aimed at young minds. "I would say – and this is anecdotally, right? – that about 20 percent of people using the Next are new to the Spectrum," he said. There's a sense he'd like to see a higher number, however.

Above: The ZX Spectrum Next looks familiar yet modern
Below: Released in 1981, the ZX81 was the first computer for many Australians.

Where next for Next?

Whether or not he'll be spearheading this drive far into the future is another matter entirely. Creating a new computer, even one based on existing older technology, is often fraught, as the chip shortage has shown all too starkly. There are no plans as yet for a third run of Nexts, even though there is obvious demand. "I was not prepared for the parts shortage," Olifiers admitted. "The second issue machine should have been much easier than the first but it has proven to be more difficult. It's been very, very tough for the team."

For the time being, Olifiers is going to focus his attention on software and the community. If a third run is announced then, in all likelihood, he's unlikely to be as hands-on. He told *APC* that he would most likely "pass on the baton to someone who can drive the Next in a full, dedicated manner."

He added: "I run a videogames studio. I'm not as diligent as I should be to run a project of this size and it needs someone who can dedicate their time 100 percent because the platform and the users deserve that."

Ideally, it will become a full-time company, he says, and one that will involve people with the greatest of passion: the Next community. "Lots of community members are already involved and I wouldn't have been able to get this far without some key people going above and beyond enabling this, and keeping me honest, reminding me of things that have to be done and helping me to achieve them," he said.

"There is a long list of incredible people who devote their time as much as I do to making this happen, but these people will be much better served with someone who can dedicate their full attention to it."

One option is to set up "some sort of democratic co-op", he said. "You'd let the community decide who will manufacture the computer and which way it will be sold and so on." But one thing he does not want to see is a move away from the essence of a ZX Spectrum.

"There is a sweet spot; a Goldilocks zone in my head between power and complexity," he said. "I don't want to abstract things into APIs and engines and things like that where all of a sudden people are so distant from the hardware that the magic is lost." He'd rather see people make the very most of what they have rather than constantly see ever more advanced versions being created.

"There's a lot of room for things with the Next that people haven't tried," he said. "The accelerator board is very under-utilised at the moment and there's so much else that can be unlocked. I'd like to see a demo scene appearing and a competition to see who can get the most out of the computer."

History has taught that developers will often get the most out a machine many years after launch, and Olifiers has a hunch this will be the case for the Next. As such, the main fun for him will be watching what people can achieve as the decade progresses. "I'm pretty sure for the foreseeable future I will be sitting back and enjoying something new every time I switch it on," he said. "I really want to think, 'okay, I did not see that coming' and actually enjoy the feeling." ■

Games can use up to 256 colours on a ZX Spectrum Next.

CHIP CHAT

JOEL BURGESS REPORTS ON THE UNUSUAL SIDE OF TECH NEWS

MUSK SAYS TESLA COULD "MAKE A ROBOT CATGIRL"

Tesla may produce Fembots in the near future, according to founder.

During an extended interview with Chris Anderson from TED on the opening of the Tesla Gigafactory in Texas, Elon Musk said that it was 'probably inevitable' that robots would someday be available as sex workers or romantic partners. "I did promise the internet that I'd make catgirls" said Musk, "we could make a robot catgirl". Given that Tesla is now focusing on developing its Optimus humanoid robot for production as soon as next year, this might not be as much of a joke as it initially appears. Musk also added that, "It'll be whatever people want, really", hinting that the sex bots may cater to more fantasies than just Musk's.

MARK ZUCKERBERG WANTS PROJECT NAZERE TO BE HIS 'iPHONE' MOMENT

Zuck needs his own Blue Origin energy to escape from the shadow of Steve Jobs.

A former employee working on Facebook's first standalone AR glasses, Project Nazere, told *The Verge* that "Zuck's ego is intertwined with [the glasses]. He wants it to be an iPhone moment." Facebook CEO, Mark Zuckerberg has always felt upset that Facebook couldn't offer end-to-end software and hardware packages to consumers in the way that Apple and Google traditionally have, but is determined that the metaverse will offer a chance to correct that. Both the standalone Nazere AR headset and the more affordable, smartphone-dependant, Hypernova AR glasses sound like high quality tech, but it's still a bit early to tell if Nazare is the new iPhone or a $10 billion a year investment in tech that's as popular as Siri.

YOUTUBER ADDS EXTERNAL GPU TO STEAM DECK 'BECAUSE WE CAN'

ETA Prime connects a 6900XT to Valve's handheld console.

Valve's handheld Steam Deck gaming device has been modified by YouTuber ETA Prime to be compatible with an external GPU. The YouTuber connected an AMD Radeon RX 6900XT to the Nintendo-Switch-like console using an adaptor for the m.2 storage slot. ETA Prime had to image Windows 11 on a microSD Card in order to run the Steam Deck with the 6900XT, since the SSD slot was now occupied. There was a significant improvement in synthetic benchmark performance with the $1,700 GPU, but in real world gaming the CPU on the US$649 Steam Deck just wasn't capable of keeping up with the additional GPU power, so while you can add an external GPU to your Steam Deck, we're not sure why you would.

BAUHUTTE ELECTRIC GAMING BED

If you're gonna be bed ridden, you might as well enjoy the ride.

The Japanese gaming homewares company that released the first gaming bed-desk setup has returned with an update to its 'forbidden layout'. The new Electric Gaming Bed includes moveable panels that transform the flat single bed into a recliner style daybed that is sleek and customisable enough to make the finest private hospital beds look like they're from the dark ages. The bed was designed for 'self-degrading gamers' that want to "incorporate games while sleeping", according to the company's website. The minimalist design includes full electric control for the ultimate in convenience and can be paired with other Bauhutte accessories to make it possible to happily spend the whole day in bed playing games. ■

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